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SELECTIONS

FROM THE

RECORDS OF THE GOVERNMENT OF INDIA,

PUBLIC WORKS DEPARTMENT.

No. CCIX.

PUBLIC WORKS DEPARTMENT SERIAL No. 4.

REPORTS

CONNECTED WITH

THE PROJECT FOR THE CONSTRUCTION OF DOCKS AT CALCUTTA.

PART I.

Published by Authority.

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1885.

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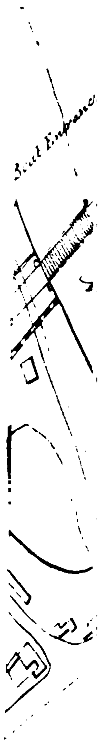

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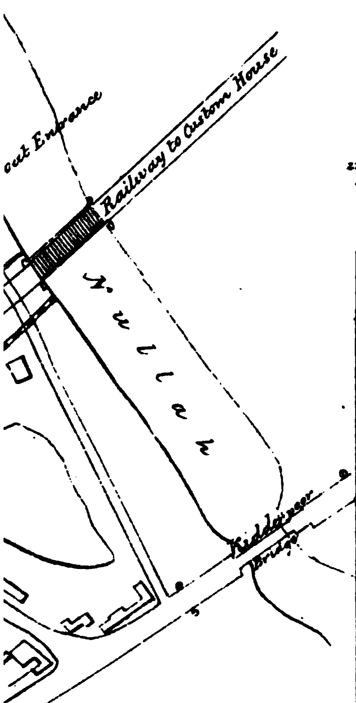

Map
of the
GROUND of KIDDERPOOR
Exhibiting
a minute of Topographical Survey
of all Pucka Buildings Compounds
Bridges Roads Tanks &c.
SURVEYED BY
ALEXENDER DANIELL
by Order of the
Wet Dock Committee.
Calcutta,
5th October 1845.

Scale 10 5¾/8 inches to the Mile

220 198 176 154 132 110 88 66 44 22 1 Furlong 2 Fur.s

Statement, Shewing area in acres, and Beegahs, of Estates, and grounds, as specied below

Description of Estates and Grounds	British Statute Acres		Begahs of 1600 Sq. Yards	
	Acres R.		Begahs	Cottahs
Area of Captn. Engledue's Estate marked A	11. 2	„	34	14
Do. ... Mr. ... Wood's Estate ... B	10. 2	„	31	15
Do. ... Do. including Motee Jheel G	18. 2	„	35	19
Do. of the Estate marked ... C	11. 1	„	34	„
Do. Mr. Prinsep's Estate ... D	17. 1	„	52	3
Do. of Mr. Reed's Estate ... E	3 „	„	9	1
Do. of Mr. Teil's 3 Estate ... F	7. 3	2	23	9
Do. of Mr. Stewart's Estate ... H	2 „	„	6	1
Do. of Messrs. Gisborne's. and Co. Estate I	2 „	„	6	1
Do. of Ramtunnoo Sircar's Estate ... J	6 3	„	20	8
Do. of Mr. Hamilton's Estate ... K	4 1	2	12	17
Do. of Kalee shunker Ghosal's Estate L	1. 1	„	3	15
Do. of Mr. Gill's Estate ... M	2. 2	„	7	11
Do. of Prince Easin's Estate ... N	6. 1	4	18	19
Do. of ... Do. ... Do. ... O	5. 3	„	17	7
Do. of ... Do. ... Do. ... P	5 „	„	15	2
Do. of Rajah Soothchurn Ghosaul's ... Q	2. 3	2	8	6
Do. of the Ground marked ... No. 1	7. 2	„	22	13
Do. of ... Do. ... Do. ... No. 2	33. 2	„	101	6
Do. of ... Do. ... Do. ... No. 3	10. 2	„	31	15
Do. of ... Do. ... Do. ... No. 4	38. 1	„	115	14
Do. of ... Do. ... Do. ... No. 5	31. 1	„	94	10
Do. of ... Do. ... Do. ... No. 6	2. 2	„	7	11
Do. of ... Do. ... Do. ... No. 7	12. 2	„	37	16
Do. of ... Do. ... Do. ... No. 8	16. 3	„	50	13
Do. of ... Do. ... Do. ... No. 9	33 „	„	99	16
Do. of ... Do. ... Do. ... No. 10	17. 2	„	52	18
Do. of ... Do. ... Do. ... No. 11	7 3	„	23	8
Do. of ... Do. ... Do. ... No. 12	8 „	„	24	4
Do. of ... Do. ... Do. including Meetee Pokhur No. 13	4 „	„	12	2
Do. of ... Do. ... Do. ... No. 14	15 „	„	75	12
	366.1	10	1107	6

Goodwyn Captn. Engrs.
Civil Architect

PHOTOZINCOGRAPHED AT THE SURVEY OF INDIA OFFICES, CALCUTTA, APRIL 1886.

REPORTS

CONNECTED WITH

THE PROJECT FOR THE CONSTRUCTION OF DOCKS AT CALCUTTA.

Report of the Committee appointed by Government in May 1844 to enquire into the practicability of providing Calcutta with Wet Docks capable of containing a part, or the whole, of the shipping frequenting the Port.

Immediate cause of the enquiry.

Lt.-Col. W. N. Forbes, Engineers.
Lt.-Col. A. Irvine, C.B., do.
Capt. H. Goodwyn, do.
Capt. T. E. Rogers, I. N.
J. Beckwith, Esq.
J. P. McKilligin, Esq.
J. S. Stopford, Esq.*

* Mr. Stopford, a few months after the Committee first assembled, proceeded to England, and Government was pleased on their proposal to appoint Murray Gladstone, Esq., Member.

Secretary.

The Secretary to the Superintendent of Marine, *ex-officio.*

1. The loss of life and property occasioned by the hurricane of June 1842 having forcibly drawn attention to the importance of guarding the shipping in the port of Calcutta against the effects of similar gales, and against the dangers to which they are constantly exposed whilst lying in the river abreast of the city, a correspondence ensued between the Government and the late Marine Board, and subsequently the Superintendent of Marine, which eventually led to the appointment of the Committee named in the margin, as announced in a letter from Mr. Officiating Secretary Davidson, No. 275, dated Council Chamber, 25th May 1844, a copy of which was forwarded to Lieutenant-Colonel Irvine, C.B., Acting Superintendent of Marine, with Mr. Under-Secretary Beadon's memo. No. 1452 of the 3rd June in the same year.

Instructions for the enquiry.

2. The Committee assembled on the 17th July 1844, when the correspondence referred to was laid before them, and their attention called to the following concluding paragraph of Mr. Officiating Secretary Davidson's letter No. 275 of the 5th April 1843, having reference to the important object of preventing the recurrence of such calamities as those caused by the hurricane of June 1842:—

> "The remedy for the inconvenience and danger attending vessels anchoring in the stream, it is apprehended, would be obtained by the construction of wet docks, capable of receiving a given number of ships; and your Board are invited to favour the Government with your views and advice as to the usefulness and practicability of the undertaking.
>
> "The points to which His Honor would direct your notice when collecting materials for your report are—
>
> "*1st.*—The quantity of tonnage, and the number and class of vessels of which it would be desirable to relieve the river by the construction of wet docks.
>
> "*2nd.*—The depth of water which it will be required to maintain at the entrance of the docks.
>
> "*3rd.*—The site to be selected.
>
> "*4th.*—The probable annual expense of an establishment adequate to the duties connected with the docks.
>
> "*5th.*—An estimate of the charges that may be levied on ships for dock-hire and to meet the annual expense of establishment and interest on the first outlay.
>
> "And lastly, whether the object in view could be effected by means of a joint-stock company, in which the Government would be a considerable shareholder, as in the Bank of Bengal, or in what other way the scheme could be most effectually carried out."

3. The Board were also informed that in particularising certain points to which attention was specially directed, it was not His Honor's wish to restrict or circumscribe their enquiries,

and this Committee, while embracing in their investigation all the points stated by Mr. Secretary Davidson, have accordingly deemed themselves at liberty to include all matters that occurred to them as likely to throw light on the subject.

Advantages, general and peculiar, of wet docks.

4. Although the Committee consider that the terrific effects of the gale of June 1842 sufficiently shew that vast benefit would be derived from the construction of wet docks in Calcutta, they deem it righ briefly to record the advantages, general and peculiar, to this river which would result from them in this port; they may be thus stated:—

1st.—Wet docks afford such superior facilities for loading and unloading ships, that the operation may be performed in *one-third of the time* at present required for these purposes.

2nd.—They secure ships against the accidents constantly occurring in crowded harbours or rivers, and they are especially calculated to protect vessels and their cargoes from injury where the tides and stream are strong; they also render them comparatively secure against the risk of fire, as the use of lights is invariably prohibited on board of vessels in docks.

3rd.—They save cargoes from pilferage and depredation, as well as from the damage to which they are exposed on being shipped or discharged in boats, more especially where the boats are generally bad and the landing-places of the worst possible description. The loss from depredation alone in the port of London, prior to the introduction of wet docks, has been estimated at £500,000 per annum, as Mr. McCulloch states; and though he considers this estimate to be exaggerated, there can be no doubt that the actual loss from this source was very great there, and is in proportion still greater in this river.

Sketch of what had been done in this matter previous to the present enquiry.

5. The Committee were naturally desirous to ascertain what had been done when the question of providing this port with wet docks was mooted in previous years, as they were aware that General Watson had many years ago not only designed, but actually commenced, the construction of docks capable of containing the number of ships frequenting the port at the early period of his engaging in the project; that long subsequently, in 1824, a Committee had been appointed to investigate the subject, and that a plan drawn by the late Major Schalch of wet docks to be constructed in Tolly's Nullah, and several other plans, had been considered by this Committee.

6. The information obtained relative to these past enquiries is scanty, and is all embodied in the subjoined extract of the present Committee's proceedings:—

Committee of 1824.

"Read a letter put in by Lieutenant-Colonel Forbes from Mr. James Mackenzie, to John Trotter, Esq., Secretary, Marine Board, dated 16th October 1826. This letter gives a brief sketch of the proceedings of the Committee assembled in 1824, and of the final close of its labours. It appears from this account that the Committee met on the 11th June 1824, and after some discussion resolved that it is necessary, as a preliminary proceeding to further enquiry, to obtain information from the mercantile members as to the amount of saving likely to accrue from the construction of wet docks capable of containing the whole shipping of the port. A memorandum was circulated accordingly, embracing the points which such an estimate involved.

Major Schalch's plan.

"The Committee met again on the 28th June 1824, when it was found that no satisfactory information has been obtained on the points referred to (perhaps because the time elapsed was too short), and the Committee proceeded to consider a plan of Major Schalch's for a wet dock at Tolly's Nullah. This plan appears to have been rejected chiefly on two grounds—one, that it involved the stopping up of the Nullah, and the other, that the scheme would have afforded inadequate accommodation to the trade of the port. No statement is given of the probable expense.

Mr. Colvin's plan.

Mr. Colvin's plan for a dock between Meer Bhur Ghaut and Nimtollah Ghat was then discussed, and the Committee wound up their proceedings by a resolution that a plan of the river from Baug Bazar to Garden Reach, shewing the nature of its bed, be obtained, and an estimat of the expense of constructing a dock on the plan proposed by Mr. Colvin, and also of that of one on the other side of the Sumatra Sand.

"The Committee was then adjourned *sine die*, on account of the Burmese war, and never again re-assembled."

Pamphlet on wet docks, dated 1824.

7. An anonymous pamphlet, dated 1824, has been furnished to this Committee by Mr. Officiating Secretary Davidson with his letter No. 463 of 7th September 1844, in return to an application addressed to him, and this is the only document or information on the subject which that functionary had it in his power to supply. The nature and object of wet docks are discussed in this pamphlet chiefly with reference to the advocacy of General Watson's plan. Their more obvious advantages are well set forth, some useful facts are stated, and some sensible remarks made, but the general tone of the production is too much that of the partisan of a particular scheme; and when the writer comes to figures and estimates, he is not to be relied on, which is strikingly exemplified in his estimate of the cost of wet docks to contain all the shipping at that time

frequenting the port, which is 8 lakhs of rupees—4 for the ground and 4 for the execution of the work! This appears to be indeed a mere guess, as no data are given for the calculation.

General Watson's plan.

There is, moreover, no detailed account furnished of General Watson's plan, but there is one fact stated with respect to it which it may be useful to record. It is, that General Watson went to the expense of changing the course of Tolly's Nullah, in order to form a space partly and mainly in its old bed for his projected wet dock, which he actually commenced, but never completed. His plan appears to have involved the union of wet and dry docks.

8. An engraving of General Watson's plan was subsequently laid before the Committee by the President; a copy of Major Schalch's plan, considered by the Committee of 1824, has also been submitted to this Committee, but without any specification or estimate of its cost; and as, like General Watson's—from which, however, it widely differs in design—it could not now, either as to site or other features, be adopted, any further description of it is deemed unnecessary. Your Committee were informed that Mr. Seppings, late Marine Surveyor to the Honourable Company at this Presidency, had furnished Government with a paper on wet docks, which was stated to be in the hands of Captain Durand, then Private Secretary to the Right Honourable the Governor General, but on application to that officer this was found to be a mistake, and no such document could be obtained.

General conclusion of present Committee.

9. It will be seen that the records of past proceedings in reference to the construction of wet docks did not much facilitate the labours of the Committee; but there was nothing in them at least to discourage the hope of finally seeing this grand desideratum for the shipping interests supplied. The Committee accordingly, at their first meeting, having discussed generally the subject proposed for their consideration, came unanimously to the conclusion that a most important benefit would be conferred on this great commercial port by providing it with wet docks capable of containing all the shipping at any one time collected, and that the measure was perfectly practicable. The mercantile members stated their opinion that it would be quite safe to calculate on 5 lakhs of rupees per annum as a return on the capital embarked in such an undertaking, and as that sum is 10 per cent. on 50 lakhs, the subject of enquiry was practically reduced to the question whether wet docks of the required capacity could be constructed for that amount. The Committee having taken measures for obtaining the information which will be set forth in the report, proceeded first to discuss the site and general design and capacity of the proposed docks,—a discussion which occupied several meetings, and led to considerable correspondence.

10. The Committee do not deem it advisable to state in the order of their occurrence all their proceedings, as they are sufficiently shewn in the minutes* of what passed at each meeting which accompany the report.

Site of the docks.

11. The site of the docks has been a subject of very earnest enquiry and of much discussion, and much time elapsed ere the Committee could come to a final decision on this point, which was rendered of very great importance by a circumstance they had not anticipated. It appeared that doubts had arisen as to the navigation of the Hooghly remaining permanently open, and they were informed that the late Mr. Greenlaw had left a long and able, though unfinished, paper on the subject, in which he had suggested having recourse to the new approach to Calcutta by one of the eastern rivers, and which would have brought ships within about 30 miles of the present port. It became therefore indispensable to procure evidence on this point that might lead to a sound conclusion, for it would obviously have been useless to fix on a site near Calcutta when physical changes might occur to remove the port to a distance of 30 miles. The Committee resolved, therefore, to make a reference through the Master Attendant to the twelve Branch Pilots, in order to ascertain whether their observation and experience had led them to the conclusion that any permanent obstruction to the navigation of the Hooghly was to be apprehended. Eleven out of the twelve, speaking from experiences of from 25 to more than 30 years, reported that no permanent change in the channels had taken place, and that no permanent interruption of the present navigation need be feared, for that as one channel deteriorated another improved. At a subsequent stage of the enquiry, and after more than one plan had been before the meeting, it was suggested by Captain Goodwyn that the Committee should consider the question whether, if a railroad to Mirzapore were constructed with its terminus at Howrah, it might not be necessary that the docks should be on the other side of the river.

12. *The mercantile members stated in reply that the construction of the railway would not much affect the question of the proper site for the docks; for that parties sending down exportable*

---

* It is not deemed necessary to print these.

goods from the Upper or Lower Provinces were not the exporters, but that the goods constantly change hands on coming down here, and are, and still would be, brought over to Calcutta for sale. That with regard to goods imported by sea and purchased for sale here or in the Upper Provinces, these are invariably landed in Calcutta, and purchased by native merchants in the city, and that it is not at all likely that this system would be changed, unless the capital itself should be transferred to the other side of the river.

13. At the first discussion on this point, without reference to the consideration of railways, which was not then mooted, the Committee had decided that the Howrah side of the river would be inconvenient as a site for the proposed docks, for that it would involve the use of boats, and consequently the risk of loss from depredation, from accidents and exposure to the elements,—nullifying, in fact, three of the principal advantages to be derived from the proposed improvement. The first site suggested was at Kidderpore, as near to Tolly's Nullah as possible, but as the ground alone in this neighbourhood was valued by the Collector at 1,100 rupees per bigha, and as valuable houses stand on different parts of it, it appeared to the Committee that the cost of the grounds and property there would render the plan too expensive to admit of its being carried out, and they accordingly gave the preference to the site near Akra, exhibited on the 1st and 2nd plans annexed.

Capacity of the docks.

14. With a view to estimate the required capacity of the docks, the Committee obtained the following returns of the number of arrivals and departures of ships, exclusive of dhoonies and coasting craft, and of their tonnage for three years :—

ARRIVALS.

	No. of Vessels.	Aggregate Tonnage.	Average.
1841	709	267,378	377
1842	643	266,437	414
1843	586	252,947	431

DEPARTURES.

	No. of Vessels.	Aggregate Tonnage.	Average.
1841	649	242.094	373
1842	654	267,887	409
1843	612	264,444	432

15. Hence it appears that the average of arrivals of ships for three years was 646, of an average burthen of 406 tons; and as in 1842 there were no less than 200 vessels in the port at one time, the Committee decided that the docks should be spacious enough to contain 200 vessels of an average burthen of 400 tons each.

General plan of the docks.

16. The Committee having thus agreed on a site and on the extent of the docks, proceeded to discuss the other essential features of the design, with reference to a rough sketch made by the President at one of their meetings, and they directed that the following letter, furnishing the data for a plan of wet docks at Akra, should be addressed to the Civil Architect:—

From James Sutherland, Esq., Secretary to the Marine Superintendent, to Captain H. Goodwyn, Civil Architect,—No. 25, dated Fort William, the 27th March 1845.

In conformity with the resolution passed at the meeting of the Wet Dock Committee on this day, I have now the honor to request that you will be good enough to prepare, for submission to the next meeting, a plan of a wet dock at Akra or Sangaroll Reach, for which, and for its adjuncts, the following are the data :—

(1) Two docks, export and import, to be capable of containing 200 ships of 400 tons average burthen.

(2) Area of the space required, 30 acres for water surface and 20 for land, including that in the centre for landing goods, &c., and for sheds, &c.; the whole to be walled in.

(3) Each dock, to ensure its effectual scour (from Tolly's Nullah by reveted drains conveying or sustaining a double railroad), to be 140 feet in breadth and 2,000 yards in length, which would allow for two ships abreast, in lines running parallel to a double row of ranges of godowns, one range for *export* goods and the other for *import*, having between them a double railroad. The water on the opposite side from the railroad and ranges of godowns to be allowed to shoal up grass slopes, thereby saving the cost of masonry for reveting the external sides of the

docks, and at the same time affording the requisite accommodation for cargo boats and for small craft necessarily admitted into the docks, and further *allowing water space at various places for turning ships*, and for moving them without coming into contact with each other. With such *external* slopes as are alluded to, it is known that the cost of digging out the docks would be *comparatively little*, as the earth could be easily carried up those slopes; for the great expense of *square tank* digging arises from the much greater distance that the soil excavated has to be conveyed. In fact, with reference to the *indispensability* of an *effectual* scour, the mode of construction referred to is not a matter of choice, but of necessity.

(4) The docks to be provided (similarly to the St. Katherine's Docks in London) with a common entrance and turning basin; this basin to communicate by locks with each of the docks (the one being for import and the other for export ships), and to have an entrance lock with three pairs of gates leading to and from the river, and rendered by the entrance basin common to the two docks.

(5) The length of the scouring drains forming the substantial base of the railroad will be ascertained from the plans, and will probably be about 5 miles.

(6) Two ranges of godowns with iron roofs will be required.

(7) A Superintendent's house.

(8) A railroad from the docks to Tolly's Nullah, and on its opposite side on to town, terminating at a point (say near the General Treasury) to be hereafter decided.

(9) Accommodations outside of the dock walls for crews, European and Native, say 5,000, to be provided.

(10) The sill of the dock gates to be 8 feet below the lowest low water of a spring ebb tide.

(11.) In further illustration of the subject, I beg to forward herewith the rough sketches made by Lieutenant-Colonel Forbes, the President, at the last meeting of the Committee, indicating the general plan of the docks, as also those of the entrance basin and scouring tunnels, which last having their heads in Tolly's Nullah, may be filled at the top of high water in it, by sluices closing when the tide in the Nullah begins to recede, and which tunnels, serving from their length and capacity for holding water as reservoirs, will enable a scour (probably with a head of 6 feet) to be passed alternately through the docks at the time of low water at Akra: this, too, in a way that would not lower the general surface of the water of the dock scoured more than a foot or a foot and a half.

17. The docks are not intended to take in the large steamers, as that would considerably increase the expense of construction, by rendering it necessary to have greater width of gates, and even greater area of the docks themselves. Captain Goodwyn accordingly prepared and submitted a plan constructed on the data above detailed, but the estimate for this plan, it will be seen, was originally R70,57,755. By diminishing the length of scour, however, as shewn in the specification, this was reduced to R55,63,730.

18. Various modifications of this plan were discussed, but the one most approved of was that described in the following extract from the proceedings:—

"This last change is that of substituting for the two docks abreast, as in the original plan and in its two modifications, two docks situated in one diagonal line extending from Akra Reach (where the entrance of the docks first proposed was to be) to a point in Garden Reach, some distance below, but on the opposite side of, the river, from the Botanical Garden House. Thus constructed, the docks, provided with two entrance locks and basins, and a central or separating lock, would form a canal directly across the bend of the land made by Akra and Garden Reaches. By this plan (as by that which preceded it) it was proposed to employ one of the docks to scour the other, the surface water level of each of them being alternately raised for this purpose by an engine of 80 horse-power. It was also by this plan provided that the goods arriving from all parts of the country in boats should be at once taken in them to the docks; and further, that a superior and comparatively secure class of cargo boats being introduced, water conveyance should be used between the Custom House and the docks—an arrangement by which it was expected that the necessarily great expense of an intermediate railroad might be avoided.

"The Committee proceeded to consider the proposed modification, but, after a brief discussion, decided that as one of the principal objects sought to be attained by the introduction of wet docks is the prevention of that pilfering of cargoes which so constantly arises, and especially in this port, from the employment of boats, besides the great loss of time they occasion in a river with stong spring tides, it was essential that goods should be carried to and from wet docks by a well-regulated railroad, as there was reason to fear that on common roads, with the hackeries in use, the plunder would be as great by land as by water; and they further resolved that the railway, instead of stopping, as originally intended, at a point on the Esplanade, near the Treasury, should be carried down by a curved line to Chandpaul Ghaut, and thence on to the Custom House.

Site finally resolved on.

"The plan constructed on these principles being before the Committee, they were about to resolve on its submission to Government, when the President, after further considering the plans and estimates, suggested that it might still be advisable, before a final report was forwarded to Government, again to weigh the consideration whether a site much nearer to town than that shewn in the drawings might not be selected, such as he had originally sketched out a plan of, as in any event it would be well to be prepared with the information which would naturally be desired, regarding the Committee's reasons for fixing on a site removed from Calcutta several miles, if by any means one nearer could be adopted. The Committee, feeling the importance of this consideration, resolved that measures should be taken to ascertain as accurately as possible the value of the property indicated, and which, lying between the two Garden Reach roads and between the Kidderpore Bridge and the Motee Jheel, was traced in pencil on the plan then before the meeting; and Captain Goodwyn, in conjunction with the Secretary, was requested to institute such an enquiry as would remove all doubt on this obviously highly important point."

19. Owing to circumstances explained in the minutes of the proceedings, six months elapsed before the valuation of the property in question could be obtained. At length a plan prepared by Mr. Daniel of the Surveyor-General's Office, under the directions of Captain Wroughton, and a valuation made from it by Messrs. Burn and Co., were laid before the Committee. Messrs. Burn and Co. valued the whole of the premises included in the coloured plan of them, on which Captain Goodwyn has exhibited an outline of the proposed docks, at R13,66,600, as shewn in the copy of their estimate annexed to the plan; but only a portion of this land is required, or about 498 bighas, valued, with the existing buildings, at R5,39,000.

20. The Committee proceeded to consider the plan of the grounds at Kidderpore, and to mark out on it the limits of the proposed docks. The quantity of ground required, and so marked off, formed about 498 bighas, and the value, according to Messrs. Burn and Co.'s valuation, is R5,39,000, as before stated. It was therefore unanimously resolved that as the locality now under consideration is much more convenient for the docks than that at Akra, and will not cost more, as it will dispense with four miles of railway, it is on every account entitled to preference; and that the Committee accordingly recommend that if it should be decided to confer on this port the advantages of wet docks, they should be constructed at Kidderpore, within the limits shewn in the accompanying plan, and which are, on the north, the Garden Reach Road; on the south, the Churen Woodpara Road; on the west, the Motee Jheel; on the east, the Lotee-hara Road: and comprising an area of about 498 bighas.

21. It was then suggested by the President that docks so situated should be provided with a locked channel, adapted for passing into them boats loaded with produce, arriving by the River Hooghly or by the Nullah itself and the Eastern canals; also that such a channel could conveniently be rendered available in aid of the means provided for scouring the docks, and which will mainly depend on rendering one of the two docks proposed (the one for inward, the other for outward, bound vessels) a scouring reservoir for the other, the level of the one being for this purpose temporarily raised by steam-engine power above that of the other. And this proposal having been approved of, Captain Goodwyn was requested to prepare an estimate in such a manner as to include the requisite cost.

22. The Committee further decided that it would be advisable to make the upper surface of the stratum of blue clay found in the intended site of the docks, at an average depth of from 25 to 28 feet from the surface of the soil, the level of their bottom. This, inasmuch as so constructed, less expensive method would suffice for rendering the wharf walls impervious to water; neither would there then be required such a large amount of engine power as with the water surface of the docks raised several feet higher (as was previously proposed) would have been requisite.

23. The minor details of the plan will still be nearly those shewn by No. 2 of the three plans, or that agreed on at the 5th meeting of the Committee, with the alteration as to the continuation of the railway decided on at the 6th meeting, the only other differences being those above alluded to, and that, in the locality here proposed, nearly four miles of railway, and consequently the expense incident to its construction, would be saved. It must, however, be observed that, in the site thus recommended, the *greater expense of the land,* and the opening of the channel into the Nullah, will be charges in *diminution of the total saving arising from diminishing the length of the railway, lowering the bottom of the docks,* and lessening the steam engine power.

24. The plan which was thus finally approved is, as will be seen by a reference to the sketch of it, a recurrence to the original design of two docks abreast, the nature of the ground not admitting of their being extended in one line without great public inconvenience. One change was subsequently made, which it is proper to notice. It is the exclusion of the Motee Jheel from the limits of the proposed docks, as it was considered that to deprive the inhabitants of Garden Reach of this lake would be a serious inconvenience to them. The plan so modified, and ultimately adopted as the best, will, in the opinion of the Committee, embrace every advantage contemplated in the construction of such works, at a cost which to them appears

moderate. The entrance is proposed to be made through the grounds marked in the plan as "Mr. Garstin's"* in a part of Garden Reach, admirably adapted for the purpose by depth of water and facility of access; and the docks are calculated to contain the number of vessels originally proposed, or 200, averaging 400 tons each.

* The premises are at present occupied by Mr. Murray Gladstone.

Estimated cost.

25. Captain Goodwyn's estimate for this plan, including all the adjuncts and the railroad up to the Custom House, is ₨45,70,586, but to this should be added, if a branch Custom House is included, as embraced by plan No. 2, a sum of ₨2,00,000, making ₨47,70,586.

26. As, however, no goods landed or shipped in the docks, where there would be a branch Custom House, would require to pass through the main one in Calcutta, the continuation of the railroad to the latter from the Esplanade might be dispensed with. The President has also suggested that the proposed railway *should be atmospheric, which would be less expensive, and not be liable to some of the objections urged aaginst railway worked by locomotive engines so near a city*, and the Committee unanimously concur in the suggestion.

27. The estimate of cost is to be considered as approximative, and based on the present prices of materials, bricks, timber, metals, &c., the market value of which varies greatly. It may be safe, therefore, the Committee consider, to allow for the cost of constructing the docks and railway the sum of 50 lakhs of rupees. This amount of actual estimate might, however, be reduced by the omission of the railway, but this, for the reasons already stated, the Committee deem it advisable to retain.

Receipts or income.

28. Assuming, then, 50,00,000 rupees as the cost of constructing the docks and works, the Committee have next to shew the receipts which might be reckoned on as a return on the capital so embarked in the undertaking, and the charges to be set off against them. On this important branch of the enquiry, one of the mercantile members, Mr. Murray Gladstone, has submitted the following details, which have been adopted by the Committee:—

"The revenue will be mainly derived from two sources: first, from dues leviable upon the shipping;—and I would make it incumbent upon all vessels, exclusive of dhoonies and coasting craft entering the river, to pay the dues to be fixed hereafter, according to the length of their voyage, and therefore to the frequency of their visits to the port, as is the case in other ports. The second source of revenue will be obtained from an impost levied on goods passing inwards when landed; and on produce, &c., passing outwards for exportation. The first-mentioned payments are usually called 'dues.' The other class of payments is known as 'wharfage rates.'

"The dues or tonnage rates vary in the London Docks, but they range, as correctly as I can ascertain, at present from 6*d.* to 1*s.* 6*d.* per ton. At Bristol the charge is 3*s.*, Hull 1*s.* 3*d.* to 1*s.* 9*d.*, Leith 1*s.* 8*d.* per ton and 2*s.* 6*d.* extra for lights; and at Liverpool 3*d.* to 3*s.* per ton, besides a dockage or wharfage rate on sugar or rice of 2*s.* per ton, on indigo at 1*s.* per cwt., on bar iron or leads 1*s.* per ton; and an outward dockage rate is likewise levied at a fixed rate per box, or per ton, or per cask.

"Taking, then, the trade of Calcutta for the past few years as a guide to a calculation, it appears that, in each year from 1840-41 to 1844-45,—

		Burthen.	
200	Ships arrived from the United Kingdom	95,070	tons
363	Do. under British colors	123,130	„
88	Do. under Foreign colors	31,100	„
*651	Ships, of an aggregate tonnage of	249,000	

And there departed in the same time, each year—

		Burthen.	
219	Ships loaded to the United Kingdom	112,360	tons
311	Do. under British colors	107,240	„
77	Do. under Foreign colors	26,740	„
607	Ships, of an aggregate tonnage of	246,340	

annually load from Calcutta.

"The import of staples, say copper, iron, lead, spelter, twist and piece goods, from Great Britain alone average 32,000 tons and 32,000 packages per annum. The export to Great Britain of seven staples—indigo, sugar, saltpetre, rice, flour, jute, and linseed,—average, for the same period, 108,600 tons per annum; or of the same staples there are exported to all quarters 185,400 tons yearly. Great Britain receives and supplies about 60 per cent. of the staples of our trade, and it will therefore be safe to estimate 50,000 tons of goods and 45,000 packages as imported annually, upon which wharfage dues may be levied. Similar dues are exigible upon the exports which it will, I think, be safe to estimate at 240,000 tons per annum; and our estimate of revenue would then stand as follows:—

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* This, it will be observed, is an average of the years 1840-41 to 1844-45, or 4 years; while in a preceding passage of the report the return for estimating the capacity of the docks was an average of 3 years 1841-42 to 1844-45—*vide* page 4.

FOR DOCK DUES.

British	563	ships inwards	218,200 tons,	
Ditto	530	„ outwards	219,600 „	
	½)1,093		½)437,800 „	
Mean	546		218,900 tons,	*R*
		at an average rate of R1 per ton		2,18,900
Foreign	88	ships inwards	31,100 tons,	
Ditto	77	„ outwards	25,740 „	
	½)165		½)56,840	
Mean	82½		28,420 tons,	
		at an average rate of R2 per ton		56,840
				2,75,740

		R	
Inwards,	40,000 tons British, at 12 annas per ton	30,000	
Ditto,	40,000 packages, at 8 annas per package	20,000	
Ditto,	10,000 tons Foreign, at R 1-4 per ton	12,500	
Ditto,	5,000 packages, at 12 annas per package . . .	7,250	
Outwards,	180,000 tons British, at R1 per ton	1,80,000	
Ditto,	60,000 tons Foreign, at R1-8 per ton	90,000	
			3,39,750
		Shewing a sum of Co.'s	6,15,490 "

The above rough statement assumes that it will be made compulsory on all ships and goods, with the exceptions noted, to pay dock dues, as the Committee consider that measure essential to the success of the undertaking.

Establishments.

29. The establishment, the Master Attendant suggests should be as follows:—

		R
Superintendent of Docks, per month		1,000
„ Deputy „		500
3 Assistants, at R150 per month each		450
3 Ditto at R120 „		360
Four Hawser Boats with 1 Manjee each, at R9	×4= 36	
And 8 Lascars at R6 per month each, R48	×4=192	
		228
	Co.'s	R2,538

POLICE.

	R
One Warden, at	100
Two Jemadars of Peons, at R10 each	20
Twenty Peons or Chowkidars, at R6 per month each	120
One Bill Sircar	50
One Writer	50
Four Office Peons, at R5 each	02
Total per mensem, Co.'s	R2,898
or per annum, Co.'s	R34,776

Income and disbursements.

30. Taking the receipts, then, as above, at R6,15,380, the statement of income and disbursements will stand as follows:—

	R		*R*
Establishment per mensem, R2,898, or per annum	34,776	Income	6,15,380
Wear and tear or depreciation on R50,00,000 at 2 per cent.	1,00,000		
Cost of keeping up Railway, 10,000 rupees per mile .	*30,000		
Balances . .	4,50,604		
Or more than 9 per cent. on the capital . . .	6,15,380		6,15,380

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* The cost of keeping up an atomospheric railway would be less.

Estimated saving by wet docks to the public.

3rd Meeting, 30th June.

31. The Committee consider the above calculations to be all on the safe side; the rates very moderate, and a saving on the expense at present incurred, as shewn by the information before the Committee on the subject. Mr. Massey, of this city, was good enough to furnish, through one of the members, a detailed statement of the time in port and all charges of a ship of 550 tons consigned to him. Mr. Beckwith submitted statements of the monthly expenses of Europe and Country ships respectively. From these data it appears that a vessel of 400 tons is on an average about 45 days in port, and that such a vessel would load and unload in the docks in about three weeks, and that her expenses would be about R68 a day, everything included, as follows:—

	R
Ordinary daily expenses of a vessel in port, including wages and provisions	33
Interest on value of block at R80,000 at 5 per cent.	11
Insurance, river risk, at ½ per cent.	2
Depreciation on wear and tear at 10 per cent.	22
Per day	68
Saving of 20 days, at R68	1,360
Charges in the docks, R1 per ton	400
Saving	*960
Total annual saving on 651 ships at R960 each	R6,24,960

32. This great pecuniary saving, *viz.*, R6,24,960 per annum, conveys some idea of the advantage that would be derived by ships from the improvement in question, but in other respects also the benefit conferred by it would be immense. Wet docks have been everywhere found of the highest importance to ships in saving them from the losses arising from accidents so liable to occur in rivers crowded with vessels, but in the Hooghly they are exposed to such accidents in a greater degree perhaps than on any other river in the world, from the violence of the *bores* at one season, and the strength of the freshes in the other. No record has been kept of the damage incurred by shipping within the limits of the port of Calcutta, and the Committee are therefore unable to give any precise information on this point, but they know that vessels frequently break adrift and come into collision with each other, and that serious injuries and great expenses are often sustained. The freshes of 1845 were very fierce, and there not being accommodation enough for all vessels in the port at the moorings, though ships were placed between the tiers, numerous accidents occurred. The *bores*, too, have been of late unusually severe. The damage sustained by the shipping in the June gale of 1842 was extensive, and one ship of considerable size was lost on the Gooserie Sand above Calcutta, and two Government steamers sunk in the river. One vessel was destroyed by fire in the past year and one narrowly escaped destruction from the same cause,—casualties carefully guarded against in well-regulated wet docks.

33. On cargoes, the actual charges of shipping and landing are, according to the Chamber of Commerce,—

FOR A VESSEL OF 400 TONS.

	R	
Inward, 200 tons of dead weight	200	
Ditto, 350 tons, or 1,750 packages light goods	400	
		600
Outward, 360, or 4,000 bags of sugar, rice, or saltpetre	420	
Ditto, 240, or 1,200 bales of jute or light goods	200	
		620
TOTAL		1,220

The wharfage dues on the docks on the same cargo would be as proposed by Mr. Gladstone:—

	R	
Inward, 200 tons British, at 12 annas	150	
Ditto, 350, or 1,750 packages, at 8 annas per package	875	
Outward, 600 tons general, at R1 per ton	600	
Or on the whole cargo		1,625
Difference		405

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* *Vide* note, page 7.

shewing a difference in favour of presentr ates; but against this are to be set off the saving of time, which in money is R960 per ship; of loss from exposure on open boats, and from pilfering, neither of which can be exactly, nor scarcely even approximately, estimated.

Pilfering, extent of.

34. It is stated in Mr. McCulloch's Dictionary of Commerce that prior to the introduction of wet docks on the banks of the Thames, the property annually "pillaged from ships in the river was estimated at £500,000 per annum." This he considers to be an exaggeration, but still it may serve as a guide to a very rough estimate of the loss from the same source on this river. The West India Docks, which were the first completed on the banks of the Thames, were partially opened in 1802. The total value of imports and exports immediately before that year the Committee have not been able to ascertain, but in 1806, the year after the London Docks were finished, the value (official) was £36,527,000, but it would probably have been considerably less for 1801. Taking it, however, to have been the same, and the amount of pillage to have been £500,000, this sum is rather more than 1¼ per cent. on the total value of the exports and imports. If, then, it was even supposed that such a loss as 1¼ per cent. was sustained from pilfering on the Thames, where there is a well-organised river police, it seems safe to assume 1 per cent. for the calculation of the amount of pilfering on the Hooghly, where the very men employed to protect property are found to plunder it, in those few instances where detection takes place. It appears, then, by the returns before the Committee, that the average annual value of the exports and imports of Calcutta for the three years 1841-42, 1842-43, 1843-44, was R14,59,47,196, or less opium and treasure, not so liable to plunder, R10,29,47,196, on which 1 per cent. is R10,29,472. The sum is enormous, and may possibly be considerably in excess of the reality, but there can be no doubt that the actual extent of depredation is very great.

Saving to Government.

35. The Committee having thus shewn the advantages to the public, and to those who may carry out the design, that would result from the construction of wet docks capable of containing all the vessels resorting to this port, have only, as respects the financial part of the question, to exhibit the saving that would accrue to Government from their introduction. This will chiefly be effected in the Preventive Service and in the Harbour Master's department, including the moorings. With respect to the first, the Committee had supposed that it might be wholly abolished, with the exception of the establishment required in the docks, by reverting to the former system of making the pilots responsible for a ship not breaking bulk till she arrived off town, and for ships outward bound not taking in cargo after they should leave the docks; but in his reply, No. 228 of the 28th December 1844, to a letter addressed to him on this subject, Mr. E. Currie, the then Collector of Customs, objected very strongly to this arrangement, deeming it unsafe for the interests of the revenue. If, then, the present plan of having a revenue officer on board of every ship in the river be continued, it will be necessary, he considers, to maintain the Diamond Harbour establishment, and that for the dhonies must in any case be kept up; so that, assuming that there are two docks, export and import, Mr. Currie is of opinion that, with an establishment for them rated at R36,264 per annum, the total saving in this department would be R1,32,404 per annum, as he thus explains:—

> "I come now to the consideration of the dock establishment. The monthly cost of the Custom House, wharf establishment is R1,862, and this, I imagine, must be retained without any material reduction unless some great changes should be made in the present system of passing goods for import and export. Taking the wharf establishment as a guide, and considering the much larger quantity of goods which would have to pass through the hands of the dock officers, as almost all imports from the United Kingdom and all free exports, with certain other descriptions of country goods, as grain, jute, &c., at present pass direct from and to the ships, I think that the dock establishment (Statement C) cannot be estimated at less than R3,000 a month, or R36,000 per annum. I assume that there will be only one gate for passing out imports, and one for the admission of exports; if goods for export are admitted by water as well as by land, some increase to the establishment will be necessary.
>
> "If there be any truth in the above calculations, the saving to Government under the head of charges for the Preventive Service from the formation of wet docks may be estimated at about R1,30,000.* I have to apologise to the Committee for the crudeness of this report, and again to recommend a reference to Mr. Walker for any explanation or further information which they may require."

	R	R
Present average charge . . .		2,11,000
Deduct Statement A . . .	35,494	
Do do. B . . .	6,848	
Do. do. C . . .	36,264	
		78,596
Saving .		1,32,404

The establishment here proposed for the docks is thus detailed in the Statement C forwarded with Mr. Currie's letter:—

C.

CUSTOMS ESTABLISHMENT,—MONTHLY CHARGE.

	R
[*] A Superintendent	300
Twenty Tide-waiters, at R100 each	2,000
Two Gate-keepers, at R150 each	300
[†] Four writers (two at each gate), each R50	200
Four Native Assistants, at R15 each	60
A Jemadar and twenty peons	90
Three Weigh Mohurirs	24
[‡] Six Weighmen	48
Total	3,022

or R36,264 per annum, exclusive of cleansing, lighting, and watching.

36. In the Harbour Master's establishment, as the pilots would conduct the ships into docks, the Committee find that the saving that would result from providing the port with wet docks would be the expenses of the Harbour Master's establishment, thus detailed:—

	R	a.	p.
Harbour Master	400	0	0
Deputy ditto	206	12	0
Seven senior Assistants	1,063	8	0
Six junior ditto	720	0	0
Clerk and peon	55	0	0
Crew for four heave-up boats	443	15	8
Crew of ten hawser boats	570	6	6
Two bheauleahs	68	0	0
Permanent crew of anchor boats	279	0	0
Per mensem	3,806	10	2
or per annum, Co.'s R	45,679	10	0

37. All the moorings, with the exception of two or three sets for Government or other large steamers, might be dispensed with if wet docks were provided for the shipping. The fixed moorings off town consist of 69 anchors of from 45 to 63 cwt., 69 sets of chain, and 69 mooring buoys; the original cost of the whole of which was R142,830. They are intended for no more than 35 ships, though as many as 44 have been put there. In the Cooly Bazar moorings there are 40 anchors of the same weight as the others, 40 sets of chain, and 40 mooring buoys, the total cost of which was R82,800. They are designed for 20 ships, but may take a few more. The swinging moorings consist of 60 anchors of from 28 to 45 cwt., 30 sets of chain, and 30 buoys, total cost R62,100, and will take 30 ships. Thus it will be seen that, including the swinging moorings, which are insecure at one season of the year, all the moorings in the river provide only for about 85 vessels, while the proposed wet docks will contain 200. The entire cost of all the moorings in the river is R2,87,430, and although Government do not sustain any loss by them, as the returns rather more than cover the expense of keeping them up, great advantage would be derived from dispensing with them: they form serious obstructions to the free course of the river, and render it dangerous to the up-country craft bringing valuable produce to this market, and to all kinds of boats, and have often caused loss of life and property.

38. The whole amount saved in the Preventive Service, the Harbour Master's department, and from the moorings, may be taken at R1,78,083.

Conclusions.

1st.—The result of the Committee's enquiry may be briefly stated as leading them to recommend the site shewn on the accompanying plans, in the vicinity of Kidderpore, as the *one* in most respects best calculated for accomplishing the objects contemplated by the construction of wet docks.

2nd.—They have ascertained that the cost of *them*, including the charge of an establishment for keeping them in efficient working order, will not exceed fifty lakhs of rupees; and that even from the very moderate dues proposed to be levied, they will afford a net annual revenue of four and a half lakhs of rupees.

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[*] This is perhaps hardly a sufficient allowance for so important a charge.—(Sd.) E. C.

[†] These writers would have to keep an account of the passing of the inward and outward cargo of each vessel corresponding in some measure with the cargo books of the Preventive Officers.—(Sd.) E. C.

[‡] This would not be a sufficient establishment of weighmen, but fewer would be required on the Custom House wharf, and the deficiency might be supplied from thence.—(Sd.) E. C.

3rd.—In illustration of the advantages which will be derived from the establishment of such docks, it must also be borne in mind that by their introduction the shipping interests will be benefited to the amount of Co.'s R8,85,360* per annum; and, further, that this calculation is exclusive of the saving (assuredly far from inconsiderable, but which they have not had the means of precisely ascertaining) arising from the *security* from losses, accidents and damages afforded to ships using docks instead of lying in an open river, periodically exposed, as is the port of Calcutta, to strong freshes and tides (occasionally accompanied by "bores"), and not unfrequently visited by heavy gales and storms.

4th.—The scheme thus recommending itself on *general grounds,* appears more especially worthy of the attention of those interested in the *shipping* frequenting the port, well known to comprise many of the finest merchant ships ever sent to sea.

5th.—The Committee see reason to conclude that the proposal for establishing *wet docks* deserves the favourable consideration of Government, partly with reference to the fact that by *their* instrumentality the existing port charges might, *without any financial loss, be reduced* by an amount jointly estimated by Mr. Collector Currie and by the Master Attendant at not less than R1,78,083 per annum.

6th.—It has already been shewn that by means of such docks the shipping interest would annually save R8,85,360; and, finally, that docks so constructed would yield an annual, and probably rapidly-increasing, revenue of R4,50,604.

7th.—The Committee having these considerations and all the other points which the investigation has elicited in view, have therefore unanimously arrived at the conclusion that the construction of wet docks would be an easily practicable as well as duly remunerative and highly beneficial undertaking. They also are unanimously of opinion that the most expedient plan for raising the requisite funds would be by means of a joint-stock company, aided by a grant from *Government* in the form of shares, and supported *by it* in a way that all experience has proved is best calculated to secure utility and to command success.

8th.—The returns upon which the statement of income is based, exclude, it will be recollected, a very large proportion of the valuable and bulky produce exported from the country, as well as the minor articles brought to Calcutta from other Asiatic ports, and, moreover, from those of Europe, of China, and of America; and the estimates having been framed on a very liberal scale of expenditure, which the Committee confidently expect will not be exceeded, they have only, in conclusion, to record their conviction that the undertaking admits of easy accomplishment, and that it may be carried out in such a manner as (while affording a handsome return to shareholders) materially to facilitate, and thereby speedily extend, the commerce of the Capital of India.

W. N. FORBES, *Lieut.-Col., Engineers, President.*
A. IRVINE, C.B. „ „
H. GOODWYN, *Captain,* „
J. BECKWITH,
J. McKILLIGIN,
M. GLADSTONE,
Members of the Committee.
J. SUTHERLAND, *Secretary,*
Wet-Dock Committee.

CALCUTTA, *1st May 1846.*

Appendix A.

Estimate framed by CAPTAIN H. GOODWYN, *Civil Architect, of the probable expense of constructing Wet Docks for the accommodation of the shipping of the Port of Calcutta, with reference to the data for the above purpose contained in a letter, No. 25 of 31st March 1845, from the Secretary to the Committee.*

FORT WILLIAM, 7TH MAY 1845.

GENERAL SPECIFICATION.

Although a scheme differing from the original one has since been contemplated, I have thought it advisible to embody the first, as it bears reference to the conditions expressed in the Secretary's letter above alluded to: the modified scheme will be given in full detail afterwards.

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* 651 ships, saving 20 days' time each, at R68 per diem, Co.'s R8,85,360.

ORIGINAL SCHEME.

The docks to be two in number, one for export and the other for import purposes, and to be capable together of containing 200 ships of an average burthen of 400 tons.

The locality is proposed at the southern end of Sankrall Reach, immediately below "Akra" farm, which the section of the river and depth of water point out as the favorable spot. The docks to be parallel to each other; each dock 140 feet in width and 2,000 yards long, with an interval of 160 feet between them; of this space, 40 feet of each quay will be occupied by fireproof landing-sheds, with the railway from the city passing between them to the western end. An entrance basin of 500 feet diameter (*vide* plan) is common to both docks, which are each entered by a separate lock, 200 feet long with single gate, whilst a trifle gate-lock communicates from the river with the basin. The two outer chambers of this lock have their floors 4½ feet below lowest low water-level, whilst the inner chamber is to be on the same level as the lowest water line. The floors of the basin and docks will also be at that level. The height of the quay will be 31 feet 6 inches from the bottom of the docks, and the mean high water level giving only 18 feet 6 inches of depth, an extra height of 5 feet is proposed to be supplied by means of two 80-horse power steam-engines; thus keeping a depth of 23 feet 6 inches always in the docks. Laying the bottom of the docks at level of lowest water line has been determined on with the foreknowledge of the much greater expense that would be incurred from sinking the floors of the docks and basin, than from affording the extra height of water by machinery. Besides, the raising of the quay walls above the level of the country affords the means of disposing of the earth from the excavated area, in raising the whole of the ground immediately in the vicinity, whereas otherwise the removal of such a vast quantity of soil would be a heavy item of expense. The form of the docks has been designed so as to secure a scour, and effect a clearance of anticipated deposits, for which reason it is proposed to afford wharfage only along the inner side, which is to be reveted and the masonry to be carried about 40 feet under the bottom, from which a gradual slope will meet the level of the ground with puddled sides. Thus large vessels will be alongside the reveted quays, and have the means of turning, whilst small craft and boats can occupy the shallow water. The scour through the docks has been originally proposed to be effected by means of a double culvert from Tolly's Nullah, with sluice-gates, which, being filled at high water, might discharge their contents through the lower level of the docks. The culverts to be elliptical, and the masonry brought up flush over the arches to form the bearing for a portion of a railway by which it is intended to keep open the communication between the docks and city. The double dotted line shews the line of the rail crossing Tolly's Nullah immediately south of the Kidderpore Bridge, bounding the eastern side of the road from the bridge, and terminating eastward of Government House, in Esplanade Row.

This point is mentioned, because it would be more feasible to effect the storing of merchandise at a terminus in godowns at that spot, than carrying the railway to the present Custom House, the purchase of land for which, if not impossible, would be at least enormously expensive; whilst a very heavy additional expense would be incurred in carrying the rail by the river-side to the Custom House, as it would pass by the most densely populated part of Kidderpore, and interfere with the steam premises or dockyard. On account of the heavy expense entailed by the above-mentioned length of culvert for scouring,—*viz.*, 4½ miles,—its length has been reduced by taking it off from a point in Garden Reach (noted on the plan) 600 yards below Sir H. Seton's house, the length of which line of culvert would only be 2 miles. This modification of the expense will be noticed at the foot of the estimate.

Fireproof sheds for merchandise to be erected between the outer sides of the docks and boundary wall. Sheds also for railway stores, waggons, carriages, repair of engines, &c. A Superintendent's house, police station and houses and drains, and for two 80-horse power lifting engines. Accommodation for 5,000 persons to be provided outside the boundary wall.

The water surface of the docks and basins is estimated at 45 acres, the land surface enclosed 75 acres, whilst the portion for the railway will be 20 acres, making a total of 140 acres, or 420 bighas. The length of the railway is 7½ miles.

DETAIL OF WORK OF ORIGINAL PROJECT.

Excavation—

Entrance Lock	300 × 80 × 30 =	720,000
Basin	600 × 7,854 × 30 =	8,479,520
Docks, including Junction Locks . .	2 × 6,900 × 160 × 30 =	66,240,000
	Total excavation, cubic feet . .	75,439,520

The cost of construction of locks, including masonry, gates, and sluices, are taken from data already in the office; the measurements are therefore not here given. The cost is in the abstract.

Masonry—	Circumference.	Average thickness.		Depth.		
Basin	1,530 ×	7 ×		40 =	428,400	
Docks	2 × 6,000 ×	8 ×		40 =	3,840,000	
	2 × 6,000 ×	5 ×		60 =	3,600,000	
	Total reveting masonry, cubic feet					7,868,400

Puddling Slopes of outer sides of Docks 2 × 6,000 × 5 × 600 = cubic feet 3,600,000

Double Culverts—Masonry . . 22,000 × 33 × 30 = 21,780,000
Deduct . . . 2 × 100 × 22,000 = 4,400,000
Total cubic feet 17,380,000

Four Cast Sluice gates.

Central Sheds—Walls . . 4 × 5,700 × 1½ × 14 = 478,800
Deduct . . 4 × 400 × 10 × 10 × 1½ = 240,000
Total masonry, cubic feet . . 238,800

	No.	L.	B.		
Wrought-iron Roofing—Centre sheds	2 ×	5,700 ×	40 =	456,000	supl. feet.
Covering over laths	4 ×	5,700 ×	24 =	547,200	ditto.
Flooring	2 ×	5,700 ×	40 =	456,000	ditto.

	Sides.	Sheds.	L.	B.		H.		
Outer Sheds—Masonry	2 ×	4 ×	2,400 ×	1½ ×		14 =	403,200	
Deduct	2 ×	4 ×	175 ×	10 ×	10 ×	1½ =	210,000	
			Total cubic feet					193,200

Wrought-iron roofing . . . . . . 4 × 2,400 × 40 = 384,000 supl. feet.
Covering over laths . . . . 8 × 2,400 × 24 = 450,800 ditto.
Flooring . . . . 384,000 ditto.
Superintendent's house.
Engine and store sheds.
Police stations.
Two 80-horse power engines, with hose and pumps, &c.
Accommodation for 5,000 persons.
Railway 7½ miles in length.
420 bighas of land.
Twenty-five 5-ton cranes.
Mooring posts, rings, fending timbers, &c.
Enclosure wall: 15,300 × 20 × 2 = 612,000 cubic feet.
3 pairs of gates.

1st ABSTRACT, ORIGINAL PROJECT.

			R	a.	p.	R	a.	p.
	Entrance Lock 2 Junction Locks } from data in C. A. Office		3,40,000	0	0			
75,439,329	Cubic feet excavation, @ 4-8 per 1,000 feet, including extra labour for overcoming land springs		3,39,475	0	0			
7,868,400	Cubic feet reveting masonry in docks and basin, @ 15		11,80,260	0	0			
3,600,000	Ditto puddling outer slopes, @ 3 per 1,000 feet		10,800	0	0			
	Total cost of docks and locks					18,70,535	0	0
	Culverts.							
17,380,000	Cubic feet masonry	@ 15 per 100 feet	26,07,000	0	0			
	4 Cast-iron sluice-gates	@ 1,500 each	6,000	0	0			
		Total Culverts				26,13,000	0	0
	Central Sheds.							
238,800	Cubic feet masonry	@ 13 per 100 feet	34,144	0	0			
456,000	Supl. feet iron roofing	@ 100 per „ „	4,56,000	0	0			
547,200	Ditto covering over laths	@ 20 per „ „	1,09,440	0	0			
456,000	Ditto flooring	@ 8 per „ „	36,480	0	0			
		Total Central Sheds				6,35,064	0	0
	Outer Sheds.							
193,200	Cubic feet masonry	@ 13 per 100 feet	25,116	0	0			
384,000	Supl. feet wrought-iron roofing	@ 100 per „ „	3,84,000	0	0			
460,800	Ditto covering over laths	@ 20 per „ „	92,160	0	0			
384,000	Ditto flooring	@ 8 per „ „	30,720	0	0			
		Total Outer Sheds				5,31,996	0	0

		R	a.	p.	R	a.	p.
	Houses and out-offices for Superintendent	...			10,000	0	0
	Engine and store sheds	...			75,000	0	0
	Police stations	...			5,000	0	0
	Two 80-horse power engines, with hose, pumps, &c.	...			1,50,000	0	0
	Accommodation for 5,000 persons	...			1,00,000	0	0
	7¼ miles railway, @ R90,000 per mile	...			6,52,500	0	0
	Twenty-five 5-ton cranes, @ R2,000 each	...			50,000	0	0
	Mooring posts, rings, fending timbers, &c.	...			10,000	0	0
	Purchase of 420 bighas land, @ 650 per bigha	...			2,73,000	0	0
		R	a.	p.			
612,000	Cubic feet masonry in boundary wall, @ 13 per 100 feet	79,560	0	0			
3	pair gates, @ 700 each	2,100	0	0			
	Total Boundary Wall				81,660	0	0
	1st Project, Total Company's Rupees	......			70,57,755	0	0
	Deduct reduction of length of scour taken from Garden Reach, 2¼ miles of culvert masonry, or						
10,055,556	Cubic feet masonry, @ 15 per 100 feet	1,508,325	0	0			
	Less 7⅓ acres, or 22 bighas, @ 650 per bigha	14,300	0	0			
					14,94,025	0	0
	Total cost, with modification of scour				55,63,730	0	0

PROJECT SECOND.

The fly-leaf on the map of the 1st Project exhibits the 2nd, which is to place the two docks in one continuous line or canal, forming a chord line to the curve in the river between Garden Reach and Sankrall Reach,—the lower or south-west end being the same as in Project 1, and the upper or north-east end opening into the river at a point just below the line of the Botanical Gardens. By having a branch of the Custom House within the dock enclosure, it is presumed that cargo-boats can enter the docks at once without unloading at Calcutta, and thus perhaps obviate the necessity of the railway, which, however, has been added as a contingency to the abstract, in case it should be deemed advisable. The lower dock is intended to form the export, and the upper the import dock; thus vessels will pass in at the Sankrall Lock, and, passing through the connecting lock, will discharge at the upper dock, and re-entering the lower dock, will receive an outward cargo. The section of the dock is shewn on a large scale on the map; 200 feet is the width proposed to be given, which provides for one row of vessels lying along the quay wall, giving them room to turn, and also allowing room for the passage of two other vessels to and from each dock. Boats and small craft have their accommodation at thes hallow sides of the docks as before. The docks have thus the means of scour within themselves, which, as it is poured through a larger area of section, it is thought advisable to revet both sides. A turning basin is shewn at each end.

The levels of the water in the locks and docks are to be preserved exactly as before, the floors being at the level of lowest low water, and the extra height kept up by two 80-horse lifting engines. Sheds for landing merchandise to the built along the deep sides of the docks, and other sheds as before on the opposite side. The same accommodation for residents to be provided as in Project 1st, and a branch Custom House to be built within the enclosure wall.

Water area of docks	52 acres.
Enclosed area	190 „
Railing, if necessary	20 „

Making 242 acres, or 726 bighas without the railway.
„ 262 „ 786 „ with „

PROJECT No. 2.

DETAIL OF WORKS.

Excavation of 2 Locks, or Double Project No. 1, 2 × 720,000 = 1,440,000
2 Basins, „ „ 2 × 8,479,320 = 16,958,640
Docks 2 × 6,100 × 220 × 30 = 80,520,000
Total Excavation . 98,918,640 cubic feet.

Cost of locks in Abstract, as before—

	Circumference	Average thickness.		
Masonry Basins . . .	2 × 1,530	× 7 × 40 =	856.800	
Docks . . .	2 × 6,000	× 8 × 40 =	3,840,000	
„ . . .	2 × 6,000	× 5 × 30 =	1,800,000	
Revetment, Total Masonry				6,496,800 cubic feet.
Masonry floor to bottom of docks, 2 × 6,000 × 140 × 5 =				8,400,000 „ „
Total Masonry				14,896 800 „ „

Every other item the same as Project No. 1.
Branch Custom House being the only addition.

ABSTRACT No. 2 PROJECT.

		R	a.	p.	R	a.	p.
	Two entrance locks and junction lock from office data . .	4,00,000	0	0			
98,918,640	Cubic feet excavation . . . @ 4-8 per 1,000 feet .	4,45,131	0	0			
14,896,800	Ditto masonry . . . . @ 15 per 100 feet .	22,34,520	0	0			
					30,79,651	0	0
	Quay sheds, as before	...			6,35,064	0	0
	Outer sheds, ditto	...			5,31,996	0	0
	Superintendent's house	...			10,000	0	0
	Police stations	...			5,000	0	0
	Two 80-horse power engines complete, as before . . .	...			1,50.000	0	0
	Accommodation for 5,000 persons	...			1,00,000	0	0
25	Cranes	...			50,000	0	0
	Mooring posts, rings, and fenders	...			10,000	0	0
	Purchase of 726 bighas, @ 656 per bigha	...			4,71,900	0	0
	Boundary wall	...			1,37,540	0	0
	Buildings for Branch Custom House Office.						
	Godowns, import and export	...			2,00,000	0	0
	Without Railway, Total . .	......			53,81,151	0	0

		R	a.	p.
	Contingency of Railway, 7¼ miles	6,52,500	0	0
	20 Bighas land, @ 650	13,000	0	0
	Sheds, &c., for stores and repairs	20,000	0	0
	Total Company's Rupees . . .	6,85,500	0	0
	If the masonry of the floor is omitted, a deduction may be effected of—			
8,400,000	Cubic feet, or Rupees	12,60,000	0	0
	Less piling to front of revetments—			
15,000	Running feet of sheet piling	3,72,000	0	0
	Company's Rupees . . .	8,88,000	0	0

Recapitulation.

Total amount of docks, with culvert from Tolly's Nullah	70,49,755	0	0
Ditto ditto ditto ditto from Garden Reach	54,55,730	0	0
Ditto ditto ditto, without ditto, the means of scour being limited to the docks themselves	41,55,730	0	0

Total amount of reveted and masonry floor docks, without Railway, Rupees .	53,71,151	0	0
Total amount of ditto, with Railway	60,56,651	0	0
Total amount of ditto, with only reveted sides, without Railway . . .	44,83,151	0	0
Total amount of ditto, with only reveted sides and with ditto	51,68,651	0	0

H. GOODWYN, *Captain,*
Engineers.

GENERAL DEPARTMENT.

Project and Estimate for the formation of Wet Docks for the Port of Calcutta at Kidderpore,

FORT WILLIAM, 1ST JANUARY 1846.

SPECIFICATION.

The above-detailed projects for the formation of the wet docks were proposed to be constructed at Akra, under the impression that the ground and property at Kidderpore would be so expensive as to be beyond the outlay contemplated; the Committee, however, being anxious to lay before Government the various positions in which the docks could be advantageously framed, have, with sanction, caused the survey and valuation of the property at Kidderpore to be made, and finding that the result was favourable, herewith annex what they consider the most eligible project for the undertaking.

The yellow colour on the drawing shews the position and extent of the proposed docks, which (unlike those at Akra) are to afford wharfage on both sides, and are to be 240 feet wide, in consequence of the length being, from the nature of the ground, less than the Akra docks. The basin will be found at the west end of the docks, connected with the river by an entrance lock through Mr. Garstin's estate, whilst a cast-iron swivel bridge will keep open the communication of the Garden Reach Road.

At the east end will be an entrance lock for boats only, which, entering by Tolly's Nullah, can pass into either dock. The space between the inner wharves of the two docks will be 230 feet, laid out as shewn in the section on the drawing,—*viz.*, by a double line of sheds at 25 feet from the quay edge, the sheds being 50 feet wide, and 80 feet space between the sheds for the railway.

At the western end, on the inner side, will be the terminus of the railway which is proposed to be carried thence, between the docks to the Custom House at Calcutta, in the form shewn by the curved yellow line, and being in length 3½ miles.

As before, the necessary steam power for keeping up the level of the water and effecting a scour will be provided, a Superintendent's and police stations, store-rooms, repair sheds for railway, accommodation for 5,000 men (crews), and the enclosure wall with its gates, &c.

The measurement and valuation of land proposed to be taken in for the docks is given in an accompanying document, but the amount included in estimate.

DETAIL.

Excavation—					
Basin . .		700 ×	700 ×	27 =	13,230,000
Docks . .	2 ×	3,000 ×	280 ×	27 =	45,360,000
Locks . .		1,200 ×	100 ×	27 =	32,400,000
„ . .		900 ×	60 ×	27 =	1,458,000
„ . .	2 ×	300 ×	100 ×	27 =	1,620,000
		Total Excavation		.	9,4068,000

Masonry—	No. of Sides.	Average Thickness.		Depth.		
Basin . .	4 ×	600 ×	7 ×	40 =	672,000	
Docks . .	4 ×	3,000 ×	7 ×	40 =	3,360,000	
Locks . .	2 ×	900 ×	7 ×	40 =	504,000	
„ . .	2 ×	300 ×	7 ×	40 =	168,000	
„ . .		900 ×	60 ×	6 =	325,000	
„ . .		300 ×	30 ×	6 =	54,000	
		Total Masonry		.	5,083,000	cubic feet.

ABSTRACT.

		₨	a.	p.	₨	a.	p.
	Entrance Locks and 2 Junction Locks	3,40,000	0	0			
94,068,000	Feet Excavation . . @ 4-8 per 1,000 feet . .	4,23,306	0	0			
5,083,000	Cubic feet Masonry . @ 16 per 100 feet . .	8,13,280	0	0			
					15,66,586	0	0
	Boat Lock				1,50,000	0	0
	Levelling and cleaning bottom				25,000	0	0
	2 Coffer Dams				1,50,000	0	0
	Bridge over Nullah				30,000	0	0
	Swing Bridge over road				1,00,000	0	0
	Central Sheds				6,30.000	0	0
	Outer Sheds				5,00,000	0	0
	Superintendent's House				10,000	0	0
	Engine and Store Sheds				70,000	0	0
	Police Stations				5,000	0	0
	Steam Engines				1,00,000	0	0
	Accommodation for 5,000 persons				1,00,000	0	0
	3½ Miles Railway, @ 90,000				3,15,000	0	0
	Cranes				50,000	0	0
	Mooring Posts, &c.				10,000	0	0
	Land, as per valuation				6,79,000	0	0
	Boundary Wall and Gates				80,000	0	0
	Grand Total Company's Rupees .				45,70,586	0	0

H. GOODWYN, *Captain,*
Engineers.

Appendix B.

Estimated Valuation o Ground and Messuages in the Neighbourhood of Kidderpore and Garden Reach as per annexed Chart, under date 5th October 1845. By order of Colonel Irvine.

		₨	a.	p.	₨	a.	p.			
A.	Property of Baboo Madob Dutt, occupied by Captain Engledue	47,000	0	0						
*B.	Property of Mr. Wood	25,000	0	0						
*G.	Ditto Motee Jheel	30,000	0	0						
C.	Property occupied by Mr. Gladstone, including pucka buildings	36,000	0	0						
D.	Property of W. Prinsep, Esq., occupied by A. Mackenzie, Esq., Secretary to the General India Steam Navigation Company, including all pucka erections	1,15,000	0	0						
					2,53,000	0	0			
	Intervening space, please to take notice, is the property of the Honourable Company. Major Irvine, of course, can affix the valuation paid for the ground and different erections and messuages thereon	......								
E.	Property in the possession of Mr. Charles Reid. Building in a state of dilapidation	32,000	0	0						
F.	Property of Mr. Teil, Tanning Works, with pucka messuages, tank, and other apparatus for tanning	95,000	0	0						
					1,27,000	0	0			
*H.	Property of Mr. Steuart	15,000	0	0						
*I.	Ditto Messrs. Gisborne and Co.	13,000	0	0						
J.	Ditto Ramtonoo Sircar	30,000	0	0						
*K.	Ditto Mr. Hamilton	12,000	0	0						
*L.	Ditto Collysunker Ghosal	20,000	0	0						
M.	Ditto Mr. Gills	6,000	0	0						
N.	Ditto Prince Easin	13,000	0	0						
O.	Ditto ditto	13,000	0	0						
P.	Ditto ditto	13,000	0	0						
Q.	Ditto Raja Suttchurn Ghosal	15,000	0	0						
	No. 1, 22 bighas 13 cottas of ground	40,000	0	0						
	†No. 2, 101 ditto 6 ditto	1,25,000	0	0						
					1,93,000	0	0			
	No. 3, 31 ditto 15 ditto, with pucka buildings	75,000	0	0						
	No. 4, 115 ditto 14 ditto, with buildings	1,40,000	0	0						
	No. 5, 94 ditto 10 ditto, ditto	1,35,000	0	0						
	No. 6, 7 ditto 11 ditto, ditto	15,000	0	0						
	No. 7, 37 ditto 16 ditto, ditto	57,600	0	0						
					4,22,600	0	0			
	No. 8, 50 ditto 13 ditto, ditto	31,000	0	0						
	No. 9, 99 ditto 16 ditto, ditto	85,000	0	0						
	‡No. 10, 52 ditto 18 ditto, ditto	45,000	0	0						
	No. 11, 23 ditto 8 ditto, ditto	20,000	0	0						
	No. 12, 24 ditto 4 ditto, ditto	25,000	0	0						
	No. 13, 12 ditto 2 ditto, ditto	6,000	0	0						
	§No. 14, 75 ditto 12 ditto, ditto	37,000	0	0						
					2,49,000	0	0			
								13,66,600	0	0
	Total Company's Rupees							13,66,600	0	0

BURN AND CO.

CALCUTTA;
24th November 1845.

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* Only a small portion of the grounds included in the above valuation are actually required for the docks—those that are marked with an asterisk; and where the whole quantity of any parcel of land and premises is not wanted, the proportion to be taken in for the dock is stated below.

† Of this portion 4 bighas are required.

‡ Of this parcel only ¼ required.

§ Of this parcel only ½ required.

Appendix C.

LETTER OF GOVERNMENT ACKNOWLEDGING THE RECEIPT OF THE COMMITTEE'S REPORT.

From CECIL BEADON, Esq., Under-Secretary to the Government of Bengal, to the Wet Dock Committee,—No. 1197, dated Fort William, the 13th May 1846.

GENTLEMEN,—I am directed to acknowledge the receipt of your Secretary's letter No. 40, dated the 4th instant, submitting your final report on the construction of wet docks in connection with the port of Calcutta, and to convey to you the thanks of the Deputy Governor of Bengal for your zealous and well-directed labours on behalf of this important public object, as well as for the body of valuable information you have collected, and the able manner in which you have set forth the practicability of the undertaking and the best method of accomplishing it.

2. His Honor approves generally of your suggestions, and will be prepared hereafter, should it be found practicable, to recommend, for the consideration of the Supreme Government, the outline of a plan for securing to the port of Calcutta the important advantages of export and import docks by means of a joint-stock company, of which the Government will, if necessary, become a considerable shareholder.

3. It will, however, be proper, in the first instance, to ascertain how far the community may be disposed to view the subject in a favourable light, and whether the estimated returns are considered sufficiently sure and remunerative to tempt persons of capital and credit to organise and take shares in the proposed company, with a view to direct profitable investment, as well as to the indirect advantage arising from the economy which the existence of wet docks is calculated to introduce into the mercantile and shipping transactions of the port.

4. With this view His Honor thinks it desirable that you should print your report, and such parts of the proceedings as you may consider necessary, to place the public in possession of the facts upon which your recommendations are founded. The opportunity may also be taken of making known the desire of Government to encourage the work, and the satisfaction it will afford His Honor to learn that a sufficient number of influential and wealthy members of the mercantile and moneyed community are disposed to associate for the purpose of carrying it out. From such a body the Deputy Governor will gladly receive proposals for forming a company either in the manner suggested, or on any other footing that on further consideration may be preferred.

5. The several enclosures of your letter are herewith returned.

SUPPLEMENT TO THE REPORT.

After the report had been submitted to Government, one of the members of the Committee suggested that public confidence in the success of the undertaking might be greatly increased by obtaining the opinion of Mr. Simms upon the plan recommended for adoption either as it stood, or with any modifications that his talents and experience might suggest. An application was in consequence made to Government to associate Mr. Simms with the Committee, for the purpose of revising the report and recording his judgment on it, and upon the plan approved of by them. Mr. Simms was accordingly, by order of Government, associated with the Committee, and the report and plans having been submitted to him, the following proceedings resulted from this arrangement:—

From F. W. SIMMS, Esq., Consulting Engineer to the Government of India, to the Secretary to the Wet Dock Committee,—dated 6th July 1846.

Having examined the proposed report on the practicability of providing Calcutta with wet docks capable of containing a part, or the whole, of the shipping frequenting the port drawn up by the Committee previous to my being appointed a member thereof, I beg to observe that I quite concur in everything therein set forth, with one exception only, and that is paragraph 26, wherein it is recommended that the railway to connect the docks with the city be constructed upon the atmospheric principle, as being "less expensive, and not liable to some of the objections urged against a railway worked by locomotive engines so near a city."

I consider it would be advisable to leave undefined the kind of railway that may hereafter be adopted—first, because the atmospheric system is still a debatable subject, and the Croydon line, which is the most extensive experiment that has yet been tried, has not, up to this time, furnished indisputable data to reason from; their engines have perpetually given way some where or other; they have, however, succeeded in getting a greater vacuum along 4⅝ miles than was ever got on the Dalkey line of 1½ miles; and although such is the fact, pumping air is found to be not nearly so simple an affair as it appeared to be at first sight, and the strain upon the machinery is very irregular. And although I have no doubt that the difficulties will ultimately be overcome, yet it would be by a series of gradual improvements that will occupy a long time; secondly, I consider that the railway being formed upon the present surface of the ground, or nearly so, will cross all the existing roads upon a level, which will be attended with a greater amount of danger in the atmospheric than in the locomotive railway.

I would suggest that the sum named in the estimate for the construction of the railway be left as it now stands, because the difference in the cost of an atmospheric single line and a locomotive double line of railway is but nominal, the earth and masonry works being the same in the two cases.

I propose, therefore, that the word "Railway" alone be used, without reference to its being atmospheric or otherwise; with the rest of the report I see no reason to dissent.

This communication having been forwarded to the President, Lieutenant-Colonel Forbes the following correspondence between this officer and Mr. Simms ensued:—

From LIEUTENANT-COLONEL W. N. FORBES, to F. W. SIMMS, Esq.,—dated 16th July 1846.

MY DEAR MR. SIMMS,—Mr. Sutherland has sent me your official letter respecting the wet docks, and from it (as previously from Mr. Murray Gladstone) I was glad to learn that with the exception of the short line of atmospheric railway, you quite concur in the report. In sending me the letter, Mr. Sutherland (as Secretary to the Committee) remarks, what assuredly is true, that "as the report is *all printed off*, we cannot alter it now;" but he observes—"We can add in a supplementary report that, at the suggestion of the Committee, you were associated with them after the 'report' (repeatedly called for) *had been submitted*, for the purpose of their having the benefit of your judgment,"&c.; and this being the case, your letter, which is rendered still more valuable by the opinion it contains regarding the atmospheric system, will appear as the most material part of the additional report.

Having been the party who, amongst a choice of difficulties, brought to the consideration of the Committee the atmospheric plan of propulsion for the segment of railway alluded to without any particular admiration of the system or any partiality for its present details more especially its long slobbery valve (which, however, in this country would hardly require "hot-ironing"), and certainly without any expectation of seeing the plan in its present form successfully applied to other than *short lines*, it will afford me much pleasure to concur with them in bringing your opinion prominently to notice in the additional report "for the guidance of the parties desirous of constructing the docks," and who assuredly will be guided by it, should some very great improvement of the air-pumping system (as, for instance, getting rid of the long valve) not have, intermediately, been successfully introduced. Although, for brevity's sake, the report contained no explanation of the manner in which the Fort, Esplanade, and other roads could be crossed by the railway, I had not mentally disregarded this important matter, and, with reference to it, I have to bring to mind that *the lower side* of any arch carrying the railway across Tolly's Nullah *must be* at least 15 feet above the highest tide level of this great thoroughfare line of inland navigation; further, that as during the season of inundation this water level is not much below the level of the Nullah's banks, the platform of the bridge bearing the railway must have even a *greater* elevation above the plain forming the Fort Esplanade. It must, moreover, be remembered that *on one side* of the *Nullah* the road leading from the Kidderpore Suspension Bridge to the Government Dry Docks, and on the other side of the Nullah the road leading from the same bridge to the Cooly Bazar and Fort, lie so near the Nullah's banks that all three (*viz.*, the Nullah and these two roads) must be crossed by the railway on arches of nearly the same height. Nor, as materially affecting expense, and as the means of overcoming objections to carrying the railway across the streets and near the houses situated between the Esplanade and the Custom House, was it overlooked that this portion of the line might possibly also require to be kept on such an elevated level as would admit of its passing over the streets on archways; it being believed that thus constructed the "godowns" (or warehouses) removed to make room for the *railway* could be replaced by others necessarily substantially casemated, and which, while adapted for *supporting it*, would (from the very circumstance of their proximity to it) yield comparatively *high rent*. These contingencies, apparently involving the *necessity* of having the railway line elevated at both ends, additionally induced me to believe that it would not have been inexpedient to have the line *centrically* so elevated as to have enabled similar archways to have been employed as the means of crossing the three roads entering the Fort, and which are already depressed 7½ feet below the crest of the glacis.

By such archway crossings all possibility of collision between the railway trains and ordinary carriages, passengers, and cattle (the latter at most seasons countless on the Esplanade) would have been prevented; but as such a mode of construction would have rendered it indispensable either to have had recourse to the expensive expedient of keeping the entire line elevated, and thereby level, or to the simpler and cheaper one of leaving its longitudinal profile in an undulating form, the latter consideration, and the impression that on so short an up-and-down line common locomotives would be unable to acquire or maintain desirable speed, first led to my thinking of the *atmospheric system*, which, from the representations of the "*Report* of the Committee of the House of Commons," the *admissions* of Stephenson, Barlow, Sir Frederick Smith, &c., and the *recorded opinions* of Brunell, Cubitt, Vignolles, &c. (all well known to you), I had reason to believe, would be found especially adapted for a short line situated *near to*, and *partly in*, a city, and otherwise affected as described. Located as adverted to the adoption of a plan obviously involving no such dispersion of ashes, cinders, sparks, steam, and smoke as locomotives are subject to, and of one which is generally admitted to be, for *short distances*, comparatively speedy, silent, and safe, would (had other considerations been equally in its favour) certainly have been advisable. Yet, observing that in the April reports of the Croydon atmospheric line *it* was then represented as working irregularly; as, further, that on occasion of some accidental stoppage of one of its trains, Sir Francis Head, a retarded passenger, attempted to explain the fact by the assumption that the "Atmospheric had fainted away," I confess even the far more favourable reports of it, and of the progress of the South Devon line for the month of *May* (received by the last mail), have by no means reconciled me to its endless valve (which I also know is not the greatest practicable objection to the plan), far less to defending *its* possible but hitherto undeveloped capabilities, so fairly alluded to by you, in opposition to your opinion that it is a system not as yet—even for short lines—ripe for adoption.

Previous to taking leave of the subject, I may mention that the circumstance of my having coined during the last fifteen years upwards of 723,000,000 pieces of money by atmospheric-propelled machinery, necessarily impresses me with the belief that the principle *does admit* of beneficial practical application; and it is but fair I should acknowledge that, by the application of such modifications as experience indicates to adapt it for the climate, I am convinced that there is no description of apparatus that could in this country be worked with less tear and wear than that *secondarily actuated by the atmosphere.*

So far, however, as our (Mint) experience goes, they will find it advantageous to work such air-pumped lines with comparatively a low vacuum, and with a *large road pipe*, so provided with regulating valves as to be unable to get out of order; nor is it unworthy of note that when we have in our main *close-topped vacuum pipe* only such a vacuum as is indicated by 7 inches of mercury, the detached travelling pistons rush into it with such almost invisible velocity as would *apparently* be sufficient for *any locomotive purpose.*

Amongst circumstances which inclined me to recommend the short atmospheric railway, it here occurs to me that I have omitted to mention there being already provided, by the plan of the wet docks, such ample engine power as by a little arrangement could easily have been applied to pumping the railway pipe vacuum; and I had, moreover, in recollection that there was now at the opposite end of the line (*viz.*, at Chandpaul Ghaut) a water-pumping engine that, with the present small aqueducts, only requires to be kept at work for a few hours of each day for a few months of each year, and which might expediently have been superseded by one of greater power, efficiently adapted for the supply of large and extended town aqueducts, and which, by being worked at night, would amply have effected this object, while leaving during the day its total power available for *air-pumping or railway purposes.* It moreover occurred to me that by the line of the railway a water-supply pipe might have been conveyed into the *Fort*, a locality in which the provision of *good drinking water* is at present very imperfect, and in which water is additionally required for many purposes (scouring the drains, baths, &c.) known, especially in the climate of Bengal, to be conducive to health and longevity.

The length of this letter, and mere allusion to the OUTLINE OF SUCH A PLAN, sufficiently prove that the attempt to have minutely detailed IT would have occupied more space than the limits of a preliminary report would have admitted of; neither did it fail to occur to me that even if I could have spared time for making the requisite illustrative drawings, it would have been highly unprofessional to have taken out of the hands of the Wet Dock Companys engineer the pleasure of preparing working plans and specifications according to the knowledge necessarily solely appertaining to himself, of what *he best* could execute.

Having reverted to the atmospheric system, your anticipations respecting its ultimate perfectibility induce me to state that, seeing daily proofs of the successful reduction to practice of the *electro-magnetic power* (on a plan invented by Dr. W. B. O'Shaughnessy) tends materially to strengthen my conviction that the attempts now making to apply *it* to the vacuum railway will eventually succeed.

Nor does the reflection that it has pleased Providence to employ this omnipresent power (the antagonist, yet cousin-german of gravity) for keeping in motion, and in order, the orbs of the universe, appear at variance with the probability that man may some day be permitted to apply *it* to propelling ships by sea and carriages by land.

Be this as it may, the intermediate step of resorting to magnetic agency as the medium of connection between the atmospheric travelling piston and the train would be an important one, inasmuch as it would ensure the dismissal of the abominable long valve, and thereby render available the power now lost by the leakiness of the longitudinal cylinder.

Fully prepared to coincide with you in the opinion that for *present purposes* it is not expedient to depend on *future* (however certain) engineering improvements, the conviction necessarily lowers the argument from mechanical transcendentalism to the Fort Esplanade.

Encroaching in any way, as for instance by railway, on the ground constituting the Esplanade of Fort William, is on many accounts objectionable. Being, *in the first place,* the only area in the vicinity of the city sufficiently cleared of trees, jungle, water, vegetation, cultivation, &c., to afford the inhabitants a chance of obtaining unvitiated air, it has proverbially, *and deservedly,* obtained the designation of the " Lungs of Calcutta."

2ndly.—With a view to keeping besieging enemies at a distance, and to securing for them the benefit of all the guns on the ramparts, it was originally directed (and the order has often been repeated) that no sort of structure should be permitted to be raised within the range of the Fort artillery.

3rdly.—Although the *Government House,* the *Supreme Court,* the *Great Jail,* and the buildings (low and easily demolished) at Cooly Bazar, are the principal exceptions to this rule, it was so strictly enforced in the time of the Marquis of Hastings that, *after* the foundations of the Scotch " Kirk" had been opened (inadvertently of course) within the prescribed limits, it was deemed necessary to have the building removed to Tank Square. It, however, in this case curiously happened that just before the rule had been remembered, it had been discovered that the foundations at the site granted *were excessively bad.*

4thly.—For one or other of these reasons the Calcutta community, the military authorities of the Fort, and the Home and Local Governments, have ever expressed the strongest desire to have the Esplanade carefully preserved ; and if this assertion admitted of doubt, the proof of it would be found in the fact that it was deemed requisite to exclude the Bishop's Cathedral from the precincts rendered, in military acceptation, sacred by the fire of the Fort guns, and in consequence it may be observed the church referred to now occupies a position far more praiseworthy in a military than in an ecclesiastical point of view—this inasmuch as having subsided to a state of perfect security in a swamp ; it is protected in front by an impassable collection of waters, strengthened on the *left flank* by the Great Jail, on the *right* by the formidable *Fives* Court.

Of these objections, the military ones might be got over by the consideration of the fact that in a siege the railway would enable the Fort to launch out right and left such heavy batteries as by subjecting an enemy to simultaneous attacks in front, flank, and rear, would necessarily greatly embarrass him—an object that indeed would be facilitated by carrying the line of railway through one of the outworks, as thus conducted it would afford the garrison the means of placing the guns on the platform-train carriages under cover.

Yet assuming the question concerning the Fort and its enemies to be thus disposed of, it remains to be noticed that although, in a philosophical point of view, locomotive engines and trains are the most beautiful of all uncreated things, there are few of the inhabitants of Calcutta, and none of its quadrupeds, who are accustomed to their transitory appearances and indescribable noises; further that, as these might primarily lead to fatal accidents, and ultimately to the abandonment by the lieges of their healthful Esplanade drives,—this unless they would take kindly to riding on the railway trains,—it would be well to avoid originating a clamour based on the conviction that the city already possesses nuisance enough, and that it would be cruel to add to their number. It must, moreover, be obvious that it would be desirable to avoid bringing railway trains so near to the Government House, and to the principal Government offices, as would be the case by the line the plans at present indicate. Now, assuming that there must be a branch Custom House at the terminus of the Inland Grand Trunk Railway as well as the wet docks, and that it would be as expedient to have the one as the other connected with the General Custom House, it occurs to me that this object, and the still more important one of uniting the wet docks with the terminus, might be effected by a line passing considerably to the eastward of the Esplanade, and which, running as nearly as possible rectilinearly from the one to the other, could have a short intermediate branch uniting each with the General Custom House, as well as with the great native bazars and the principal European commercial establishments. Such a line could, *if desired*, be made coincident in direction with that of a main sewerage tunnel, adapted for enforcing the efficient drainage of Calcutta; and as it would be difficult, if not impossible, to obtain a site *for the railway* without including space enough *for the tunnel*, the arrangement would apparently be conducive to the economical accomplishment of *both*.

As affecting this point, it requires to be noticed that in Bengal no description of road can be kept dry without having alongside of it drains or excavations of such sectional area as to afford the material for embanking it; and it may also be observed that these excavations are usually either *so deep* as to become in the rains water-courses speedily ruinous to the road, or *so broad* as to form long shallow lakes—necessarily occupying (at great first cost for ground) a large surface of land.

In passing through a town, the costliness of the latter mode of construction would render its adoption impracticable, and in consequence it does not appear unreasonable to suppose that both the earth required for raising the railway and the means of preserving its dryness and solidity, might most cheaply be afforded by some such arched excavation, or tunnel, as has now been adverted to.

Should the matters thus mentioned, more especially those relating to the *Terminus, Custom House*, and *Wet-Dock line*, appear to you worthy of consideration, I should be much obliged by your letting me know your conclusions respecting them.

Having had considerable experience in the way of raising heavy works on bottomless alluvion, or on Bengal (*alias* the worst possible) *foundations*, I have no hesitation in affirming that for either docks or railways *they* may be rendered perfectly trustworthy. I have also (within reasonable limits) very great confidence in iron-tied masses of masonry composed of well-burned *brick-earth* such as, throughout India, *is* almost everywhere met with—a subject that was first brought to my notice by the late Lieutenant-Colonel Lockett, who having produced some bitumen-coated bricks affirmed to have been found in the ruins of *Babel*, wished me thereby to state the possible height of *its* ancient tower—an enquiry that a Scotchman naturally answered by conditional interrogatories solely serving to express that it was a question not to be asked. It, however, appeared to me that the bricks referred to, and said *at least* to have been brought from the ruins of the temple of Belus, were not calculated to carry a greater weight than those occasionally manufactured in Bengal; take, for instance, those which were employed in building the walls and works of the old Fort containing the celebrated "*Black Hole*," and which, when removed to make room for the present Custom House, were found to be composed of brickwork so nearly resembling granite in solidity and iron in hardness, that (mining not being allowed) it could only be sub-divided by steel-headed battering rams.

Possibly, under all the circumstances of the case immediately in question, it would be as well to leave the precise line of the wet-dock portion of railway for future consideration; and if you and the Committee are of this opinion, the conciseness of our supplemental report may form a desirable contrast with the length of this epistle.

From F. W. SIMMS, Esq., Consulting Engineer to the H. E. C., to LIEUT.-COL. W. N. FORBES, Engineer,—
dated Chinsurah, 20th July 1846.

MY DEAR COLONEL FORBES,—I have received your long but interesting letter concerning the wet docks and atmospheric railway, which subject you had evidently well considered. There is no doubt of the practicability of the scheme in either form (atmospheric or locomotive); but, as you observe in your last paragraph, *it will* be best to leave *these details at present undetermined, as the railway will not be required until the docks are ready for the shipping.* Your proposal to add a short supplemental paper to the report is the best thing that can be done as the case now stands.

When we meet I shall have much pleasure in talking over the whole subject of your letter which is both interesting and important.

The whole of these papers having been considered by the Committee, they concur in the suggestion of Mr. Simms, and recommend that the kind of railway to be constructed from the docks to town be left undetermined (and consequently the line) until the construction of them is so far advanced that they can be completed by the time the railway is finished.

Experience recently acquired (partly at Mr. James Mackenzie's new docks at Howrah) enables the Committee to state their belief that it will be found practicable to lay the sills of the entrance gates of the wet docks 9 feet below the level of the low water of the lowest spring tides—an arrangement which will be attended by the advantage of allowing ships to enter or leave the docks several hours before, or several hours after, high water.

W. N. FORBES, *Lieut.-Col., Engineers,* *President.*
*
T. E. ROGERS, *I. N., Offg. Supdt. Marine,*
H. GOODWYN, *Captain, Engineers,*
J. BECKWITH,
J. McKILLIGIN, *Merchants and Agents,*
M. GLADSTONE,
Original Members.
F. W. SIMMS, *Consulting Engineer to the H. E. C.*
(Appointed after the original report was submitted.)
JAS. SUTHERLAND, *Secretary.*

Report upon the project of the Calcutta and Diamond Harbour Railway and Dock Company.

From F. W. SIMMS, Esq., Consulting Engineer to the Govt. of India and Director of the Railway Department, to G. A. BUSHBY, Esq., Secretary to the Govt. of India,—dated Calcutta, 21st January 1847.

I beg to submit the following report upon the project of the Calcutta and Diamond Harbour Railway and Dock Company, for constructing a line of railway from Calcutta to Diamond Harbour, with warehouses, buildings, and docks there, the proposed capital of the Company being one million sterling, to be raised in 50,000 shares of £20 each.

2. I have visited the locality for the purpose of examination, in company with C. R. Prinsep, Esq., the Chairman of the Provisional Committee in India of the said Company, from whom I have received information respecting the project in question.

3. The object of the Company is the construction of suitable docks for the reception of all the large class of shipping that frequents the port of Calcutta, and of a railway along the present line of public road to facilitate the transit of persons and merchandise between the said docks and the city of Calcutta.

4. No definite plan for the docks appears to be at present determined upon by the Company, but they express themselves satisfied of the feasibility of constructing them upon any plan that may be required or approved of by Government. The site they have chosen lies between the termination of the road to Calcutta on the bank of the Hooghly and the Hadjipore Creek. It is also proposed to employ the creek in connection with the docks by constructing a dam or an entrance lock near its mouth.

5. The railway is proposed to be constructed along the present highway, which the Company will render sufficiently wide for that purpose, and also for a highway for the transit of hackeries. In doing this, they will excavate a canal on one side of the road, for the purpose of widening the embankment, and this canal, which, while it answers the purpose of drainage will serve for lighters of small draft to pass up from that district of country into Tolly's Nullah with the weightier freight from the docks, as iron castings, guns, &c., and also rice, firewood, and other produce from that district of country. The Company require that the Government will give the present road and all land necessary for their several objects, free of cost, and also power to levy a suitable toll on boats using the roadside canal.

* Lieut.-Col. Irvine, C. B., a member, embarked for England in the *Precursor* the day after he signed the report.

6. In forming a judgment on the proposed scheme, I must consider the construction of the docks as its main feature, and the railway as subordinate thereto, for it will doubtless be dependent thereupon for its traffic; for simply considered as a railway between its termini, I cannot imagine that it would succeed as a commercial speculation.

7. And first it may be asked, are docks at all necessary, or required, for the purposes of the commerce of the port of Calcutta? and if so, which is the most eligible site for their construction?

8. The present accommodation for the shipping frequenting this port is in the River Hooghly, where they lie at anchor in the tideway opposite Fort William and the City of Calcutta: the extent of the accommodation is about 4½ miles in length, averaging about 300 yards in breadth, the large ships anchoring only in one line about the middle of the channel. It will be evident that the ships are thus much exposed to danger from a variety of causes, and serious accidents and losses have occurred from storms, the violence of the "bore," fire, and other causes, which would all be obviated by a well-regulated docking establishment.

9. During the time of the freshes, when the river is swollen by the waters from the interior of the country, these waters in their downward passage meeting the spring tide produce a troublesome and inconvenient, if not dangerous, agitation or flurry in the waters, so much so that, as I am informed, it has been found necessary in some cases to cast off the steamers from the ships which they were towing. As a proof of the strength of these freshes, it frequently happens, when at their height in the months of August and September, that they prevent the tide advancing so high up the river as Calcutta, and according to the information I have received (from respectable authority) ships have at such times, before the introduction of steam towing-vessels, been detained as long as ten days off Garden Reach, without being able to get up to Calcutta. And in August 1840, the ship *Gloucester*, belonging to John Husband and Co., lay at Calcutta nearly a month without swinging once, but rode with her stern down the stream.

10. Besides the liability to accidents to the shipping, very great opportunities exist and are made available for the plunder of merchandise, and fraud to an enormous and unknown extent. This is admitted by all parties, and on which account I believe that there are none who would not advocate the construction of docks as the only sure remedy for so great an evil. This system of plunder, or river piracy, is not peculiar to Calcutta; it exists in all ports, and has only been subdued or annihilated by enclosing the ships, with their export and import cargoes, within lofty dock walls, allowing of ingress and egress only through certain well-guarded gateways. To such an extent was the system carried in London, that its prevention led to the construction of the first public docks at that port, and was the chief argument adduced before Parliament to obtain the legislative sanction to that project. Some curious particulars relative to this fact I have inserted in Part V of Appendix B.

11. In the report of the Wet-Dock Committee, dated 1st May 1846, the construction of wet docks for the port of Calcutta is strongly recommended upon satisfactory grounds, as in every respect beneficial to the trade of the port, the Government (or Custom House Department), and to the shipping interests. The site selected by the said Committee for the construction of the docks was at Kidderpore, near to the present Dockyard of the Honourable Company.

12. Assuming, therefore, that docks are a desideratum to the port (a fact I am most strongly convinced of), the question to be determined is the most suitable site for their construction, whether it be at Kidderpore, as recommended by the Wet-Dock Committee, or Diamond Harbour, as proposed by the Company bearing that name.

13. The situation of Diamond Harbour is 50 miles along the channel of the river from Calcutta (see Appendix A, Table I) and about 31 miles by land, whereas Kidderpore, where the Wet-Dock Committee proposed the construction of the docks, would require but 3½ miles of railway to connect them with the city. In this respect, therefore, the Kidderpore Docks would have the advantage of being situated near the houses and offices of the mercantile community, and consequently would be more easily accessible than at Diamond Harbour; but I apprehend that this is an advantage more apparent than real, inasmuch as it is seldom necessary for very immediate and unforeseen communication to take place between the merchant and the ship. A railway to Diamond Harbour would doubtless supply all that would be desirable under this head.

14. The real advantage in regard to pecuniary considerations in the conveyance of merchandise between Calcutta and the docks that Kidderpore would have over Diamond Harbour for their site, would be the saving of the cost of transport over about 28½ additional miles of railway, which, according to the rates now charged in England for such traffic, would amount to four shillings and nine pence per ton for the whole distance.

15. Against such an advantage must be set the additional cost to the shipowners arising from the longer time occupied by their ships in passing up and down the additional fifty miles of river, and that of both a difficult and dangerous navigation; also the saving of so much of the Government charge for pilotage, and probably some small reduction in the rate of assurance, owing to the dangers above Diamond Harbour being avoided. But upon this latter point I should lay but little stress, as the greater difficulties lie at the Sandheads and the mouth of the river, as is evidenced by the fact that of 30 ships lost between the Sandheads and Calcutta, 26 were lost below Diamond Harbour, and 4 above that place (see Appendix A, Table V).

16. According to Table III of Appendix A, made from statements obtained through Captain Rogers, Acting Superintendent of Marine, from Captain Clapperton, Master Attendant, and several members of the Pilot Service, the average saving in time to the ships would be 3¾ days, both in passing to and from Calcutta when the vessel is not towed by steam; and when she has the benefit of a steam-vessel, would probably average throughout the year two days, or, rather, two days' hire of the steam boat would, upon an average, have to be paid, because they charge half a day's hire extra for their returning: thus a ship of 1,300 tons pays R300 per diem for the steamer towing her, and R150 return hire for the trip, so that for 3 days between Calcutta and the sea the charge would be R1,050, or £105 sterling.

17. Table IV, Appendix A, shews the number of ships that have entered and left the port of Calcutta each year since the renewal of the Honourable Company's Charter (1832-33) with their tonnage, and also the number of ships towed by steam and the number not so towed, by which it appears, of 7,235 arrivals to the present time, 1,082 were towed by steam and 6,153 were not towed, shewing that only about one seventh of the ships arriving availed themselves of the services of steam-vessels; and of 7,215 departures, 1,697 were towed, and 5,518 not towed, shewing that less than one-fourth only used steam-vessels. Upon examination of the table, however, it appears that the use of steam towing-vessels is on the increase.

18. The cost, therefore, to a ship of large burthen, say, for comparison with the report of the Wet-Dock Committee, 400 tons, and drawing from 17 to 18 feet of water, up to Calcutta, beyond what the cost would be if she stopped at Diamond Harbour, would not be less than the following estimate :—

For a Vessel towed by Steam.

	R	*a.*	*p.*
Expenses of ship for two days as given in Wet-Dock Committee's report, paragraph 31, per day R68	138	0	0
Steam towing, R300 per diem	600	0	0
Pilotoge	92	8	0
Present to Pilot	100	0	0
Moyapore duty, 1 anna per ton	25	0	0
Row-boat, 2 days at R13 per diem	26	0	0
Total Co.'s Rupees .	981	8	0

This upon 400 tons of cargo would give R2-7-1 per ton, or about 4 shillings and 11 pence nearly.

19. It has already been stated in paragraph 14 that the cost of conveying each ton of merchandise along the railroad from Diamond Harbour to Calcutta would be about four shillings and nine pence, and the above result shews that it now costs to reach Calcutta in a 400-ton ship four shillings and eleven pence.

20. I will now take as an example a larger-class ship, namely, of 1,300 tons drawing 22 feet of water,—the foregoing example being taken, as above stated, for the sake of comparison with that given by the Wet-Dock Committee :—

Daily Expenses.

	R	*a.*	*p.*		*R*	*a.*	*p.*
For wages, provisions, &c.	250	0	0				
Interest on the value of block at R3,50,000 at 5 per cent.	48	0	0				
Depreciation on wear and tear at 10 per cent. . .	96	0	0				
Total per day .	394	0	0	× 2 days	788	0	0
Steam towing R300 per day, 2 days					600	0	0
Pilotage					147	8	0
Present to Pilot					100	0	0
Moyapore duty, per ton 1 anna					81	4	0
Row-boat, 2 days at R13 per diem					26	0	0
Total Co.'s Rupees .					1,742	12	0

This divided by 1,300 for the cargo in tons gives ₨1-5-1 per ton, or about 2 shillings and 8 pence per ton, the result being in favour of the docks at Kidderpore, as compared with those at Diamond Harbour, of 18 pence per ton. This is an extreme case to cite, because the average of the ships resorting to Calcutta lies between 400 and 700 tons.

21. From the preceding calculation it would appear generally that as respects the cost of delivering goods either by being landed at Diamond Harbour and then conveyed to Calcutta by rail, or taken the whole distance by ship, upon an average of the various classes of shipping, there would exist no material difference either in favour of the docks at Kidderpore or Diamond Harbour. The latter, however, has the advantage of saving to a ship fifty miles of a difficult and dangerous navigation, the whole being but little more than one hundred. And furthermore, in all probability the shipowners would find it less necessary to use steam if their vessels stopped at Diamond Harbour than at present, the passage of the upper part of the river being avoided.

22. Table V of Appendix A contains a statement of the vessels wrecked between Calcutta and the Sandheads from the year 1833 to 1846, whereby it appears that of 30 vessels wrecked in that period, only 4 were lost above Diamond Harbour; the rest below that place.

23. Table VI, Appendix A, contains a statement of the number of ships that had grounded in the river between the years 1835 and 1844. It appears from the abstract given at the end of the table that of 885 ships grounded in that period, 553 were below Diamond Harbour, and 327 above that place, it not being ascertained where the remaining 5 grounded. Upon the examination of this abstract it will, however, be observed that the difference in the number of groundings above and below Diamond Harbour decrease in the latter years, and most likely arises from the increased use of steam towing-vessels since a reduction of full 25 per cent. has been made in the towing charges, for there appears to be no reason to expect that the river itself is undergoing any improving changes.

24. Tables V and VI shew, what must be admitted by any one, that the navigation about Diamond Harbour, the whole distance to Calcutta, is both difficult and dangerous arising from the numerous shoals and sands which exist throughout, particularly those called the James and Mary, which are doubtless occasioned by the confluence of the Damooda and Roopnarian rivers with the Hooghly; and if the shipping are to continue to pass up as high as Calcutta, it would be desirable (if a few years more does not render it absolutely necessary to remove those obstructions to the free navigation of the river, if engineering skill can accomplish it. A suggestion for this object may not here be out of place.

25. I have, from time to time, since my residence in Calcutta, given this subject some consideration, feeling, as all must do, its desirableness, and various projects have occurred to me and been rejected upon further consideration. The dredging machine early came under review as one means of its accomplishment; but I am free to confess that at present I anticipate but little or no success from this or any other remedy, so long as the cause of the shoal continues in action. But whilst recently engaged in the examination of the Rivers Damooda and Roopnarian as a member of the Committee appointed to report upon the embankments of the rivers of Bengal, I observed that there appeared to be no great difficulty in turning the waters of the former river into the bed of the latter, at a point a few miles above the ferry crossing of the Midnapore road; and subsequently my esteemed friend Murray Gladstone, Esq., suggested to me that to dam up both those rivers and change their course would be a practical mode of removing the cause of those dangerous shoals.

26. The adoption of such a course would indeed be the removal of the cause, and thereby render that of the shoals a comparatively easy procedure, and I have no doubt that Nature would in a great degree engineer for herself, and require no great amount of assistance in doing what would then be required for the entire removal of the impediment. Before, however, such a project could be pronounced to be practicable, it would be requisite to determine by an operation of levelling whether the water of the Damooda could be diverted as above suggested, and the latter river with its increased volume of water into the Tingorcolly at a point a little south of Tumlook.

27. The Tingorcolly River falls into the Hooghly nearly opposite to Mud Point; and although it may be argued that the deposit from the three rivers being concentrated, might be productive of a dangerous and awkward shoal in this part of the river, yet from its breadth at this place, namely 5½ miles, it is not to be expected that the navigation would experience any obstruction; neither do I consider that it would materially affect the existing channel, called "Mud Point Channel," which is on the opposite side of the river to the embouchure of the Tingorcolly, and stretches from Kedgeree Point nearly to Silver Tree Obelisk. On the

contrary, I am of opinion that the great deposition to be expected near the Tingorcolly shore would, by closing the present shallow and useless channels on that side, cause an increased volume of water to pass down the present main channel and thereby improve it.

28. In even hinting at the proposition above set forth for turning the Damooda from its present embouchure, it must be remembered that in paragraph 45 of the report of the Committee above named, on the embankments of the Bengal rivers, it is strongly recommended that the River Damooda be maintained in its present bed for the purposes to which it is at present mainly applied, namely, the conveyance of coal from the mines at Raneegunj to the City of Calcutta, it being with all its defects not badly adapted for that trade, which the turning of the course of the river, as suggested in the preceding paragraph, would wholly subvert. It would therefore be requisite to make provision for that traffic, unless the proposed railroad be made to the North-West Provinces through the Raneegunj district, which would at once do all that could be desired for the carriage of the coals.

29. Provision, however, could be made for the traffic, independent of the railroad, either by making a lock in the dam that must be constructed for diverting the waters, whereby the coal-boats could pass along the same route as present, or otherwise by rendering navigable what in my recent journeys I have taken to be an old course or branch of the River Damooda, that leaves the river some miles south of Burdwan, and appears to be nearly, if not quite, connected with the nullah or nullahs that terminate in the River Hooghly above the station bearing that name. In confirmation of this opinion I have since learned that Major Rennell in his Bengal Atlas calls the water-courses I speak of "The old Damooda," which he represents as terminating at "Nia Serai."

30. The carrying out of any such project as the foregoing would necessarily involve a large outlay of capital which must be defrayed either by the Government or by the parties interested in the improvement of the river above Diamond Harbour, should it be deemed desirable or become absolutely necessary to be done. Or else the expense would have to be borne jointly; the parties last named would be chiefly those connected with the wet dock at Calcutta, if the scheme recommended by the Wet-Dock Committee be carried into execution.

31. The fact of the site of the docks at London, and at many other ports, being close to their cities, may be adduced against the adoption of Diamond Harbour in this instance, but I am far from being sure that they should be taken as precedents for similarly locating such establishments elsewhere; for it must be borne in mind that so lately as 1828, when the last of those docks were completed, railways, except for mining and similar purposes, had never been applied, and the present locomotive engine with its high speed and great power was also unknown at that time. The formation of the first of the great railways had only just been begun, and its success, either as an engineering question or as a commercial enterprise, held by the well informed to be but chimerical. It would, therefore, be too much to say that if the docks at London had now for the first time to be constructed, advantage would not be taken of our present experience in railways to place them further down the river, probably as near to its mouth as circumstances would admit of, that the full effect of the tides in facilitating the arrival and departure of shipping might be obtained, and the interference with valuable property for the construction of the docks avoided.

32. Against the site of Diamond Harbour it has been stated that it is a very unhealthy locality, and that great mortality existed amongst the crews of the Honourable Company's ships when they lay at that place many years ago. I have therefore endeavoured to ascertain if it be a fact that the place is more than usually unhealthy; and, if so, whether it arises from local causes that might be removed by efficient drainage or other requisite means, or from distant causes, as the jungly districts of the Soonderbunds, over which at present we could have no control.

33. It appears, however, that whatever may have been in former years the state of the climate of the place, it is not now more unhealthy than other like localities in this part of Bengal. Mr. Childs, the intelligent Harbour Master at Diamond Harbour, informs me that neither spleen disease, ague, nor any other of the diseases incident to Bengal are prevalent; and that so far from the place appearing to be unhealthy, only *one man* of his establishment, consisting of about *eighty persons*, had died during the last seven years; and that at the adjoining Custom House establishment *none* had died during the same interval. It is true that Mr. Childs' establishment, with the exception of himself and family, are nearly all natives; but still it is good evidence in favour of the climate, as such a rate of mortality amongst the natives is extremely rare.

34. If it therefore becomes a question how the locality came to be reputed unhealthy in ormer years to the seamen frequenting the place, it should be first ascertained, if possible,

whether or not such was really the fact, or if more seamen died there than now die in the same time belonging to a similar number of ships lying in the river off Calcutta. This would be a difficult question to be answered, from the absence of proper records, but it is certainly a fact that a great number of seamen die annually at Calcutta at the present time. And in England I have repeatedly heard amongst medical men that "Calcutta was the most sickly port in the world for ships to go to." May not this arise in a great measure from the intemperate habits of the men themselves, rendered peculiarly dangerous by the Bengal sun, and from their unhealthy occupation in stowing the cargoes into the holds of the ships, where they are breathing a heated and most noxious atmosphere? Such causes are unconnected with the climate of the district, and may have had much to do in occasioning the great mortality reported to have existed amongst the seamen at Diamond Harbour.

35. To secure as much as possible the sanitary condition of any town that might gradually arise at Diamond Harbour in consequence of the establishment of the docks, power should be given to competent parties to enforce a system of arrangement, construction, and drainage that would ensure this object as far as the climate of Bengal will admit of. Calcutta itself was formerly much more unhealthy than it is at the present day, and will become less insalubrious in future years, as the improvements now in contemplation and proposed by His Honor the Deputy Governor of Bengal are gradually carried out.

36. Having now described what appeared to be the leading points for consideration respecting the eligibility of the site as compared with Kidderpore, the only remaining questions respecting the docks affect its capabilities in an engineering point of view; and first generally I would say that in respect to its capabilities for such an engineering operation, it is as well situated as any place in Bengal. The anchorage ground along its river front is unexceptionable, with a most ample depth of water, and as safe as any reach in the river, being sheltered from violence of the south-west monsoon by the opposite shore of the river, and from the north-east monsoon by the Diamond Harbour shore; the trending of the reach near the eastward of which Diamond Harbour is situated is west by north nearly, and the only other direction of wind that could affect the anchorage would be south-south-east, neither of which prevail or are violent throughout the year. The "bore" in passing up from the sea would have little or no more effect here than it has upon the shipping lying off Calcutta; and, indeed, the effect of either the winds or of the bore might almost be omitted from consideration altogether, as the ships would never be at anchor in the river, except occasionally for short intervals at the time of ingress or egress from the docks. The objections under this head equally apply to docks in any part of the river.

37. If it be ultimately resolved to carry this scheme into execution, some previous careful consideration should be given to the selection of the best point for the situation of the entrance lock, that vessels getting out of harbour and desirous of going to sea at once might not experience difficulty or delay during the prevailing south-west monsoon. Diamond Harbour, or rather Hadjipore Creek, lies almost in a bight, and I am apprehensive, but am by no means certain, that if the entrance lock be constructed near that place, a strong wind from the south-west would interfere with the vessels getting clear of the entrance: but if the entrance be made somewhat higher up, vessels on leaving the harbour would at once get down on the larboard tack; the bight being below them would give room for so doing. The opinions of nautical men would, however, settle this question; and there is abundant suitable space above the Hadjipore Creek for the purpose. A survey of the river and land extending from Hospital Point above Diamond Harbour, to Chingoree Creek below that place, would be useful, if not necessary, in this part of the investigation.

38. The Company propose converting Hadjipore Creek into a basin, as stated in paragraph 4. Upon this point I have only to remark that it is well suited for the purpose, as it contains a sufficient depth of water, namely, 2½ fathoms, at a distance of a mile or upwards from the river.

39. In Appendix B will be found tables of the areas of water surface and extent of wharf accommodation in the docks at the ports of London and Liverpool; and Appendix C consists of a table of the leading dimensions of large sailing and steam ships, which is so much data required for consideration in planning of docks with their locks, &c., &c.

40. At Diamond Harbour the rise of spring tides is about 18 feet, and neap tides 12 feet; in some extraordinary tides it has risen 24 feet. At Calcutta the rise of springs is about 15 feet. The time of high water at Diamond Harbour on full and change days is 12 o'clock; at Calcutta it is about half past 2.

41. As respects the nature of the soil and all other points connected with the subject, it is sufficient for present purposes to assume that the soil at Diamond Harbour is equally suitable for the purposes in question as Kidderpore, or any other part along the side of the river.

42. The cost of construction of the requisite docks and warehouses, &c., is also a subject of high importance, as concerns the parties proposing to carry out the work. They, however, as before observed, have no definite plan, and consequently no estimate; but they quote a plan, report, and estimate, formerly drawn up by Major (now Lieutenant-Colonel) Boileau, for such a work as is now proposed, wherein the estimated cost was put down at £350,000. "But," says the Chairman, J. Bagshaw, Esq., "so much appears likely to be called for in addition to the items he enumerated, that nearly double that sum may possibly be required. The probable amount, therefore, may reach to about two-thirds of the proposed capital; but the shareholders may rest assured that the Directors will only call for a sum that shall perfectly satisfy the efficiency of the undertaking." They, however, afterwards fixed it at £500,000, or half of the proposed capital, which is one million sterling.

43. In the absence of a definite plan, the readiest means of testing the probability of the sufficiency of such an estimate is by comparison with the estimate of Captain Goodwyn, R.E., published with the report of the Wet-Dock Committee, for if the docks proposed at Kidderpore would be ample for the trade of Calcutta, the cost of the one would in all probability not differ very materially from that of the other. The estimated cost of the Kidderpore docks and all its appliances, are (approximately) estimated, exclusive of land and the railway, at Company's Rs35,76,586, or, in round numbers, about £357,658; whilst the Chairman of the Diamond Harbour Company states that their docks will not exceed £500,000; therefore, if the former sum be sufficient for the docks at Kidderpore, the latter may, for the sake of comparison, be deemed ample for those at Diamond Harbour.

44. Having now stated all that appears to be necessary respecting the docks, I shall have but little to remark upon the proposed railroad to connect them with the City of Calcutta: the distance will be about 31 miles, constructed along the present line of road, with a canal formed on one side, the whole of the distance, to allow of craft of small draught passing from the docks to Tolly's Nullah, affording a conveyance for heavy goods, as guns, castings, &c., as well as for the produce of the country, and also salt.

45. The whole of this part of the project is practicable and easy, the country being quite flat, and no bridges requisite of sufficient magnitude to merit particular notice.

46. The construction of the canal will be attended with very trifling cost, on account of its being necessary to make considerable side cuttings the whole of the distance, to widen the present embankment of the road for the reception of the railway, and of the common highway, which it is proposed still to leave for the use of hackeries and the public generally; the earth required to form such additional embankment or causeway will be obtained by widening one of the present side drains to form the canal; the necessary labour consumed in the construction of the embankment will very nearly make the canal also, by having the earth excavated in a suitable form, instead of being dug out in dangerous mis-shapen holes here and there, as is too frequently the case in making side cuttings in India. The only additional expense would be some little outlay for extra excavation and trimming, and the construction of some bridges for communication.

47. There appears, however, to be a serious objection to the proposed plan of making the railway and common highway thus side by side for so great a distance, because horses and bullocks are generally frightened at the sight and noise of the engines and trains when they proceed at high velocities, but not so much so, and sometimes not at all, when they move more slowly. All this, however, soon wears off where the same cattle are frequently exposed to the like appearances and noise, but which on a public highway is seldom the case, more especially one so little frequented as that to Diamond Harbour.

48. It may be said in answer to this that when the railroad is opened, together with the canal, there will be less traffic on the highway than ever. This will probably be the case, but still the liability to serious accident both to the train and to the traveller by road will remain, which is very objectionable. I would rather recommend, if it be deemed necessary to have a public road at all, that another be made at some little distance off (very little will suffice); if this be done, there will be no occasion to widen the present road for the reception of a single line of railway, which, with the necessary passing places, is all that I think would be requisite for a very long time, and perhaps be ultimately found sufficient for all purposes of the traffic Neither would I in such a case recommend the construction of the canal,—therefore the expense incurred in widening the existing causeway or making the canal would be applicable for the construction of another road, and doubtless would go very far towards its completion.

49. It may be said, why not leave the present road as it is, and construct the railroad at some distance therefrom. The answer is, that for the small amount of traffic that will pass over such a road a less solid foundation would suffice. The present highway was constructed for the traffic to the Honourable Company's shipping when they formerly lay at Diamond Harbour, for which purpose it was made with a firm foundation. And if *upon this the railroad be constructed*, a considerable saving of expense would accrue to the Company, and the very limited traffic be sufficiently well provided for. This originally good road from neglect has been more or less impassable at places for a length of time ; it is now, however, undergoing repairs.

50. The portion of the Company's capital appropriated by the Chairman to the construction of the railway and its contingent works is £300,000, the docks being £500,000, thus leaving the sum of £200,000 as a margin for unforeseen contingencies.

51. In giving an opinion upon the estimates for the docks, it must be remembered that I have assumed the estimate for Kidderpore Docks to be sufficient for docks of equal capacity at this place ; therefore, if that estimate be sufficient for the object it was made for, it is clear that the Company's £500,000 will be ample for their project ; and I have no doubt whatever but the £300,000 will also cover the cost of a single line of railroad such as I propose, and the remaining £200,000 will be applicable to unforeseen contingencies which always arise in works of such magnitude. The proposed capital of the Company, therefore, would upon *these data* be sufficient for all the objects to be accomplished.

52. Appendix D, Tables I to VI, shew the average cost per mile of railways in Great Britain, France, Austria, Prussia, Belgium, and America : for those of England and Belgium I have before me the lengths of the several lines, and am enabled thereby to add the average cost of those railways, which I cannot at present do for the others. The 57 British railroads named in the table form a total length of 2,177½ miles, and cost £76,137,441 ; giving an average of £34,965 per mile. The average cost of a double line of railway in Belgium was £17,252, of a single line £8,142, and of the whole taken together £15,313 per mile.

53. Of the American lines I have not sufficient particulars even to know in most cases whether the lines are double or single, and I therefore cannot compute the average cost of each kind. The average cost of the whole of the lines given in Table VI amounts to £4,844 per mile ; but this fact is of but little use compared with the knowledge of the cost of each kind of line. I have before me a document by F. A. Chevalier De Gerstner, an Engineer of European eminence, who travelled in America, wherein he states that a single line of those railways costs about 20,000 dollars, or, in round numbers, about £4,000 per mile.*

54. The cost of the American railways would appear generally to be far under that of the European lines ; and this being popularly known, has led to the proposal that the railways in India should be constructed after the American model, thinking thereby to ensure an equally low outlay ; but it should be remembered that the circumstances and requirements of the two countries, as also of the climate, are greatly dissimilar, and that the appliances of the one country neither exist in, nor are suitable to, the other.

55. Those of the American lines which are constructed at so small an outlay are, I believe, chiefly made through districts where timber can be had either for felling, or at a very small cost ; whilst, on the other hand, we find that where timber is not so plentiful, and the traffic great and well developed, as it is in the populous and wealthy districts, a more substantial or European form of railway is constructed, and, of course, at a much greater cost. This will go a long way to explain the reason of the disparity in the several expenditures as set forth in Table VI, Appendix D,—although no doubt an uneven surface of ground or the existence of rivers has much to do with this great outlay, and leads to this better kind of construction ; as the maintaining of cheap timber works on so extensive a scale would probably be ultimately found the most costly on account of their repairs and restorations. Thus the cost of the Philadelphia and Wilmington line was per mile £32,450 ; the Baltimore and Ohio, £12,444 ; Harlem, £27,500 ; Washinton Branch of the Baltimore and Ohio, £11,010 ; Philadelphia and Reading, £10,526 ; Philadelphia and Norristown, £10,000 ; Jersey City to New Brunswick, £11,765 ; Columbia and Philadelphia, £10,544 ; Boston and Lowell, £12,453 ;—on none of which railways were rails laid down of more than 56 lbs to the yard, on many only 45 and 40 lbs ; on others named in the table, nothing more than plate iron fastened down to the surface of wooden rails was used, and this appears to have been the general plan for the low-priced railways (on some of which I believe no iron at all was placed), and they were mostly only single lines.

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* After this report was written, No. CLXX of the Edinburgh Review came to hand, wherein the writer on "Railways at home and abroad" states that the average cost of the passenger lines in America may be taken at about £9,000 per mile, and the average speed 15 miles per hour.

56. Besides the quantity of timber used in the construction of the permanent way, many of their rivers are spanned with timber bridges, as on the Utica and Syracuse Railway, where the Mohawk River is crossed with timber, in one span of 100 feet; also the Oneida Creek, which is crossed with one span of 84 feet and sixty of 29 feet each (no contemptible work), and many others. Such an extent in the application of timber is quite as it should be in a timber-bearing country, and where the climate, &c., is not unusually detrimental to its durability.

57. In India, however, the case is widely different; so many destructive agente are constantly at work upon timber that it is desirable to use it as sparingly as possible, and not only on that account, for in Bengal and the North-West Provinces (at least along the line of country selected, and proper for the railroad) another particularly good reason exists against its extensive use, namely, that little or no timber is to be had near the line, of suitable dimension or quality for the work; for although it passes through an immense extent of jungle country, yet the timber therein is mostly a small-sized saul, so thin as to be applicable to little else but the fencing, wherever posts and rails may be used for that purpose; and along the Dooab for hundreds of miles there is no timber at all either available or suitable. Therefore, whatever quantity of that material may ultimately be employed in the construction of the railroads in this part of Bengal and the Upper Provinces, must be brought from the hill countries a great distance, and consequently at a great expense; and I shall be much mistaken if the advocates for wooden railways in Bengal would not find them anything but cheap in their first cost, as well as in their subsequent maintenance.

58. It appears, therefore, that these considerations afford a sufficient answer to the advocates of the cheap American railroads for India. The Americans themselves are now, if I am rightly informed, gradually replacing their early temporary railways by those of a more substantial structure. Therefore for India, all things considered, I would advise that the railroads be made in the most substantial manner, as being the most durable and economical in the main.

59. It has been also stated (and said to be upon competent authority) that a railway from Calcutta to the Upper Provinces constructed in the most "efficient manner capable of transporting the whole traffic of the country, with a double line of the best and strongest construction," would cost upon an average per mile Company's R44,000 (about £4,400).* This includes the cost of bridges on the route proposed, over the Jellinghee, the Bhaugiruttee, Soane, and the Ganges twice,—namely, at Benares and at Allahabad,—besides the many other rivers and nullahs which, although denominated small in this country, where they are compared with the Ganges, &c., yet in England they would be considered great; and likewise it includes all necessary engineering and surveying.

60. The sum named (£4,400) is less than the average of all the American railways as given in Table VI, which I have shown to be constructed in a manner quite unsuitable to the climate of this country. But the statement I allude to professes to provide for nothing short of "*a most efficient construction*, with a double line of rails," &c. The lowest cost of the European railroads are some of the English lines (see Table I, Appendix D),—namely, Aylesbury Junction, £8,710; Hayle, £6,940; Arbroath and Forfar, £9,214; Dundee and Arbroath, £8 570; Sheffield and Rotherham, £9,470; Gravesend and Rochester, £13,333; and the Norfolk, £13,150. Next are those of Austria, Table III,—*viz.*, £11,675 and £16,360. But the Belgian railroads, which are continually quoted as samples of cheap railroad construction, average £17,252 per mile for a double line; and certainly no country in the world is better adapted for railway purposes, either as to level surface or the absence of rivers. The extent of labour for earthwork must have been trifling,—quite as little, mile for mile, as it can possibly be from Calcutta to the Upper Provinces (judging from my knowledge of the two countries), and also in the absence of any bridge that would bear comparison in magnitude with what will here be required over some of the nullahs, much less such crossings as the Bhaugiruttee, Soane, and the Ganges.

61. The last table (VII of Appendix D) gives the actual cost of constructing the permanent way *only* of many of the British railroads, and also their average cost. This table will shew to any unprofessional person the cost of that important part of such works, for it is impossible that the upper works of Indian railways (the permanent way, as it is technically called) can be *less costly* than in England, inasmuch as nearly all the materials for the

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* See *Friend of India*, 23rd March 1843. Since the preceding pages of this report have been printed, the author has perused the pamphlet of "An Old Indian Postmaster," and finds the article referred to in this note is therein quoted as authority both for the route and cost of the railway.—The existence of the article in question was unknown to the author until he saw it mentioned in the *Friend of India* for June 4th, 1846, which was upwards of two months subsequent to the transmission of the Railway Commissioners' report to the Government.

same must be brought from thence, and therefore the charge for freight and the subsequent land or water carriage added to the price in Britain must make the Indian outlay the greater of the two, unless any diminution can be made in the cost of sleepers, blocks, ballast, or labour, which I do not expect will be the case, except perhaps in the comparatively small item of labour; but this is very doubtful, as it will require a better class of men than the ordinary labourers (or coolies) to do the work, because this operation must be performed with great accuracy, as both life and property depend much thereon in railway travelling: I see no reason, therefore, to expect but that the cost of the permanent way on the Indian lines will exceed that of the British lines.

62. According to Table VII, the smallest outlay per mile for the permanent way double line was on the Birmingham and Gloucester, namely, £3,708; and the highest on the Blackwall, £7,872. These differences chiefly arise from the difference in the weight of metal used, and the variation in the price of iron, &c., at different times. I have known rails to be contracted for at £7 per ton, and also as high as £12 and upwards, and immediately preceding my leaving England, in 1845, we made contracts for a large quantity at £10-10 per ton, which is about the price at the present time, £10 having been the average for several years past, and appears likely to continue so for some time to come. The average cost of the permanent way per mile of all the railways in the table amounts to £5,167.

63. For all the leading or trunk lines, or those upon which a large and heavy traffic is expected in India, I would recommend nothing short of the most substantial kind of construction, and with rails of not less than 80 lbs. to the lineal yard, the chairs and fastenings to be also of the most perfect kind (those formerly used being too slight to ensure due stability). Such a mode of procedure will be found in the main to be the most economical, especially in a country where the climate is to a certain extent unfavourable to such works, and numerous destructive causes are in continued action.

64. The cost of a most perfect form of permanent way only for a double line of railway through Bengal and the North-West Provinces will average about £7,500 per mile complete, being exclusive of earthworks, masonry, or fencing, &c. If this statement be correct,—and it is borne out by Table VII of Appendix D, allowing for the difference in the weight of rails and chairs, as well as freight to and carriage in India,— it shews the fallacy of the statements that have hitherto been put forth respecting the cost of railways in Bengal, more especially when it has been proposed for a much less sum than the permanent way alone would actually cost; in addition thereto, to execute all the ordinary earthworks, drainage and fencing, and to span the Jellinghee, the Bhaugiruttee, the Soane, and the Ganges twice, besides several minor rivers which in the rainy season would well compare with the Thames at London, or even make it look small.

65. To return, however, to the cost of the proposed line from Calcutta to Diamond Harbour. I consider, as I before stated, that the sum proposed to be set apart by the Company for its construction will be ample for the purpose.

66. The only remaining question for consideration is that of the probability of the project yielding an adequate return for the capital expended. The Chairman of the Company makes the following statement, shewing an expected clear income of nearly 20 per cent., supposing the capital to be £800,000 :—

PROFITS ESTIMATED FROM THE RAILWAY.

	£	s.	d.
Tonnage on the rail as per returns, inclusive of three-fourths of the import registered tonnage, 613,575 tons, at 2*d*. per ton per mile for 30 miles	153,393	0	0
PASSENGER TRAFFIC.			
First class, such as Military and Civil Servants of the E. I. C., proceeding to Europe, the Cape, New South Wales, and other stations, either on business or furlough, merchants, captains, agents, passengers of ships, &c., say 10,000 at R3 per head	3,000	0	0
Second class 20,000 at R1½, such as the officers and crews of vessels, European artificers and others	3,000	0	0
Third class—Troops at a certain fixed, and natives at a very low rate .	1,500	0	0
	160,893	0	0
ct 40 per cent. as probable working charges	64,357	0	0
	96,536	0	0

PROFITS FROM THE DOCKS.

	£	s.	d.
Taking the lowest possible average in the year that 1,000 ships averaging 300 tons will enter the proposed docks; and that 5s. per ton be charged as a minimum rate, to include all fees, &c., we have	75,000	0	0
Profit from warehouses at first	20,000	0	0
	95,000	0	0
Deduct 40 per cent.	38,000	0	0
	57,000	0	0
To this add the Railway returns	96,536	0	0
Total amount of income .	153,536	0	0

"And we have an amount verging on £20 per cent. per annum as the income of the undertaking, taking this small and imperfect calculation as the basis."

67. The Wet Dock Committee in their report, paragraph 30, make a statement shewing a profit of 9 per cent. upon the outlay for the proposed Kidderpore Docks, upon the assumption that it be made "incumbent upon all vessels, exclusive of dhoonies and coasting craft entering the river, to pay the dues to be fixed hereafter according to the length of their voyage, and therefore to the frequency of their visits to the port, as is the case in other ports."

68. The disparity in the amount of expected profits by the two parties calls for notice, and shews, what experience again and again has proved, the difficulty of estimating the probable returns of any great undertaking. In Europe this has been particularly striking in all matters of the kind, more especially as respects the railroads. In the present instance, however, it would be safer to take the smaller sum (9 per cent.) as the expected income from the docks; and let us see what profit the returns from the railroad will probably yield.

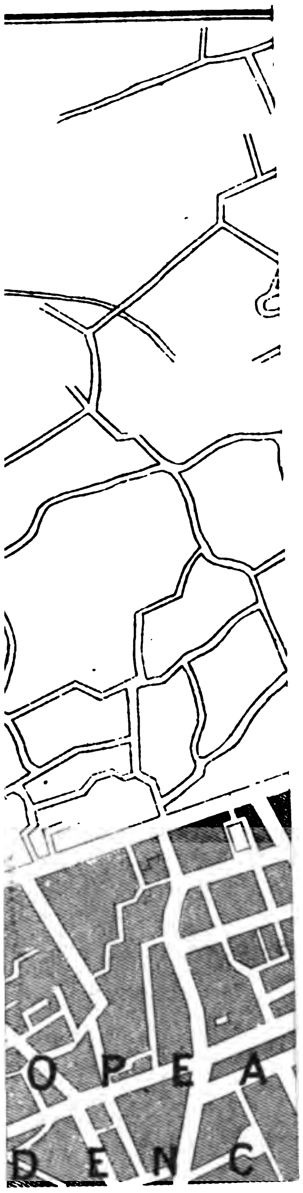
69. In paragraph 28 of the Wet-Dock Committee's report it is estimated that "50,000 tons of goods and 45,000 packages are imported annually," and the exports are estimated at 240,000 tons per annum. We will assume that one-third of this will go by craft up the river, and the remaining two-thirds by the railway; this will represent the expected goods traffic along the line.

The number of passengers arriving at Calcutta, taking the average of the last three years (see Table VII), will be—first class, 2,166; second class, 6,545; and assuming the like number of departures, which will be about the fact,—for although so many of the adults who arrive in Calcutta die in India, their numbers are made up by the births that take place,—we have therefore—first class passengers 4,332, and second class 13,090. The returns per annum will be as follows:—

PASSENGERS.		£	s.	d.	£	s.	d.
First class, for embarkation and landing 4,332 at each	6s.	1,299	12	0			
Ditto estimated at 1,000 going and returning to Sandheads and Docks, 2,000 one way, at each . . .	6s.	600	0	0			
Second class, for embarkation and landing 13,090 at each	2s.	1,309	0	0			
Third class, work-people, labourers, &c., 3,000 going and returning = 6,000 one way, at	6d.	150	0	0			
					3,358	12	0
MERCHANDISE.							
Goods, 193,333 tons, at per ton	4s. 9d.	45,916	11	9			
Packages, 30,000, at each	1s.	1,500	0	0			
					47,416	11	9
TOTAL .					50,775	3	9

The management, maintenance of way, and the working expenses would be about £25,000 per annum, leaving a surplus of £25,775, or in round numbers 8½ per cent. per annum, upon the estimated outlay of £300,000.

70. Assuming that the docks will yield a profit of 9 per cent. upon £500,000 and the railroad £8½ per cent. upon £300,000, we have a wide difference from the anticipated profits of £20 per cent. as set forth in the prospectus; but it is due to the authors of that statement to observe that the difficulty in predicting the amount of any traffic is always great, and in this country also, at the present time, the working expenses of a line of railway is far from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being known with certainty; therefore the estimate of returns and expenditure may be considered as approximate only; and to the best of my judgment I have not exaggerated it in favour of the railroad.

71. Whatever laws and regulations are suitable to the docks at Kidderpore would be equally applicable to, and requisite for, those at Diamond Harbour, such as making it compulsory upon shipping above a fixed tonnage to pay the dock dues, &c. For prejudice in favour of old customs is so strong that I am doubtful if an option was left to the owners of the shipping either to use the docks, or proceed up to Calcutta and lie in the river as at present, whether or not it would take a long time for those parties to be satisfied that their interests and that of the community would be better provided for by their using the docks; and thus for want of early support, so noble an undertaking might become ruinous and be abandoned. This, I apprehend, applies equally to Kidderpore or any other place which induced the Wet-Dock Committee to propose that the payment of the dock dues be made compulsory.

72. It certainly appears to be no more than just that those enterprising capitalists who risk their property in the construction of a work calculated to promote the commercial prosperity of the country should receive protection and encouragement in their undertaking, which would be done by making the payment of dock fees compulsory, at least for ships above a certain tonnage (say 300 tons); vessels of less burthen might still be allowed to go up to Calcutta free as at present, without unduly crowding the river.

73. No compulsory power as to the dock dues should in justice be fixed in perpetuity, but for a given term of years only, for changes in commerce, as in all other things, are continually taking place, and it might hereafter become necessary or expedient to construct other docks or appliances for trade, and therefore the monopoly should only continue until the first Dock Company shall have had a reasonable time to develope their business and bring a return for the capital expended.

74. In the Act of Parliament authorising the construction of the London Docks, there was a clause rendering it compulsory upon all ships entering the port of London laden with wine, brandy, tobacco, and rice (except ships from the East and West Indies, which used their own docks), to enter and use these docks for the period of twenty-one years from the date of their opening, which monopoly expired on 30th January 1826, when the use of the docks became optional like the others; and subsequently the St. Katherine's Docks were constructed, which would have been a hopeless speculation during the existence of the monopoly above named.

75. In conclusion, I have only to observe that I believe all the arguments adduced by the Wet-Dock Committee in their report of May 1st, 1846, as to the advantages to be derived to the trade and commerce of this port, and also of the great saving to the Government, are equally applicable to the present scheme, and the whole therefore appears to resolve itself into a question of site—whether Kidderpore or Diamond Harbour is most eligible for the purpose. I believe that I have taken all the necessary and prominent points into consideration, and if I have omitted any, it has arisen from ignorance of them. Mercantile men may see objections to either site that have escaped my notice, but if the facts are as they at present appear to me to be, all things considered, I see no great advantage that the one site possesses over the other.

Memoir accompanying a letter addressed to the Most Noble the Marquess of Dalhousie, Governor General of India, &c., on the subject of Dock Accommodation in the Port of Calcutta.

GENERAL STATEMENT.

Increase of Trade without Dock accommodation a proof of the magnitude of the trade.

That the commerce of Calcutta should have remained until the present time unassisted by the convenience, security, and economising advantages afforded by the construction of wet or floating docks, although a legitimate matter for surprise, may be taken as a proof of the energy, vitality, and profitable character of a trade which has increased to its present magnitude notwithstanding such a deficiency, and further as a fact to be brought to advantageous account in combining the construction of docks on a safe and extended scale with the course of trade as developed and concentrated by the Railway system.

Situation of Calcutta.

The situation of Calcutta is inland and convenient to internal intercourse. The distance between the Sandheads at the mouth of the river and the town is 120 miles, and the position of the city from whatever reasons, political or commercial, it may have been chosen, is at a point in the river up to which the tide maintains its full range in rise and fall, and above which the character changes to that of a purely inland course.

The River Hooghly.

The River Hooghly itself is the first and principal outlet from the main Ganges, and forms the western boundary of the extensive plains commonly called the delta of the Ganges, the lower side or seaboard of which is locally known as the Soonderbunds.

The Delta of the Ganges.

The whole of the soil or material of which the delta is formed is alluvial, being the deposit accruing during many ages from the waters of the Ganges; this character belongs also to the land for many miles to the west of the Hooghly, no mountains, hills, or even stone, being visible between the sea and Calcutta, nor for many miles above it.

Rise of Tide.

The rise of tide at Calcutta is occasionally at springs 14 feet, but, like all tropical countries, the river is subject to a periodical inundation, during which the violence of the current is excessive.

Maximum rise of River.

The maximum rise of the river surface at this period is about 8 feet, and velocity of the stream 7 to 8 miles per hour. The rise and fall of tide is prevented, and the ships, while the freshes are at their height, cease to swing at their anchors.

Variation in level of River.

Bore.

From the highest high water to the lowest low water the variation in level amounts to 18 feet 6 inches, and in the dry season or north-east monsoon, when the river is lowest, the flood tide advances up the river with a violent "bore," which, although it only breaks where the water is comparatively shallow yet rolls up the river in a huge wave, little less than 5 feet in depth, suddenly reversing the position of ships and creating violent commotion among the vessels themselves, and still more among the smaller craft used in great numbers for the transport of cargo.

Quays do not exist.

Quays for the approach and use of shipping do not exist in Calcutta, neither are there any fixed landing-stages, jetties, or floating piers, partly perhaps owing to the questionable nature of the river-side foundations, and the objections to attaching vessels to a quay wall during the bore, and also from a general absence of energy and enterprise in the local commercial interest. Local undefined rights in the shore may have prevented enterprise from embarking in their erection, and under a general and indefinite idea that a comprehensive plan would some day be devised for securing greater advantages, the river banks remain almost in a natural state.

Steam Tugs; their commencement.

Trade nevertheless increases. Ships have reached and continue to reach Calcutta with a small percentage of loss. In 1829 the first steam tug was in active operation on the river, and since that time the increase of their number has been the only improvement upon the avenues of external trade that has been practically carried into effect.

Small loss of vessels under steam towage.

Under the guidance of steam, as stated by the Noble Marquess the Governor General in a recent despatch, only one vessel in tow of a steamer has been lost in the Hooghly during the last twenty years, and that occurred below Diamond Harbour.

Pilot Service.

Moorings.

Of the Pilot Service and the Harbour Master's department we shall not here enter detail; political changes may help to open up that which is now exclusively under Government control. The moorings, lights, surveys, the pilot vessels, and even the row-boats occasionally used in towing, are all Government property and maintained on a Government foundation, excellently managed and presumably sufficient for the trade, but devoid of all the self-improving energy which characterises the institutions of Great Britain.

Such is the general position of the Mercantile Marine in Calcutta.

NAVIGATION AND ENGINEERING.

Breadth of River.

The river immediately fronting the town is of an average surface breadth of more than half a mile, one half of which at least is throughout available for anchoring and mooring of all sizes, the deep-water channels having generally seven fathoms water at the lowest tides.

General features of channels.

Passing from the state of the river and its general features in what is more strictly the port of Calcutta to that of the course from thence to the Sandheads, we find the channel in the main to be little subject to variation; within the banks, however, the changes in the position of the sands, shallows, and deep reaches are considerable both in position and level.

Movement of sand.

The movement of sand is perpetually downwards, notwithstanding the violence of the flowing tide: the quantity of detritus brought down from the Ganges and the tributaries of the Hooghly during each rainy season is immense, and the materials composing all the shoals move progressively southwards.

Effect of land waters and flood tides.

Changes are repeated.

Variations consequently occur in the course of years, depending on the balance of power in the land, waters and flood tides, the former depending on the state of the sand-banks at the head of the Bhagheeruttee, where the Hooghly receives its water out of the Ganges, and the latter varying with the force of the monsoon. Changes, however, are not altogether gradual, but return after intervals to a similar condition; and it must be borne in mind that, along with the variations which daily navigation brings to light, and which are more or less similar repetitions from year to year, there is a constant and unseen movement of the whole bed of the river seaward.

Dispersion of sand and mud.

The sand and mud which are discharged from the mouth of the Hooghly become principally dispersed in the Bay, and, being partly driven to the eastward or lee side of the entrance, tend to the constant growth of the Soonderbund shore.

Opinions as to permanent shoaling of the Hooghly.

We are aware that opinions have been expressed, and lately strongly urged, that the accumulation of sand in the Hooghly is likely to produce a permanent shoaling, and that the river is even now in imminent danger of becoming impassably barred. The object of this memoir is at least to assert that these changes are not permanent, although periodical; that the river has been before now in a condition equally embarrassing, if not more so; and that more benefit will accrue to the navigation of the river and port by a close investigation of the channels, and practical measures for their improvement, than from the adoption of a new line of approach, although more resembling a tidal channel, the sea entrance of which we fearlessly assert is infinitely more difficult and dangerous than that of the Hooghly, and which lies under this peculiar disadvantage, that whenever the Hooghly does discharge itself of the sand accumulated in it, the greater portion is deposited in the eastward Soonderbund mouths and their connected sand-banks.

We proceed to the engineering features of the works we propose.

ENGINEERING FEATURES.

The principles (here repeated) which in our opinion should be adhered to in forming the docks for the port of Calcutta are—

Several rules for the formation of docks at Calcutta.

That the docks should be in the immediate neighbourhood of Calcutta.

That they shall be in such a position as to command the best entrance from the Hooghly River.

That they shall be in favourable proximity for securing access to and from the most free and roomy portion of the usual anchorage.

That they shall be in close conjunction with the railway station, capable of admitting branch and connecting lines, and of securing the advantage of having all goods moved, on rails within the docks, with carriages adapted to the general traffic of India.

That they shall allow of perfect separation between export and import trades and progressive development in area and number, a single dock being first made and enlargements carried on as occasion may require.

That they shall be designed with every view to facilitate the arrangement and diminish the expense of the collection of customs.

That provision be made for watering with the best water, and the prevention and extinction of fire.

That the dock heads should be in a situation commanding an uninterrupted view of the river reach below.

That the entrance should not be in an embayed position, but at the same time, while avoiding the inconvenience of silt in the entrance, the danger of the opposite extreme—***viz.***, a wasting or too prominent shore—should not be forgotten.

That attention be paid to the best and most effective method of keeping the docks filled without creating impediment by the settlement from the Hooghly water.

How to be carried out.

We propose to carry them out in the following manner, premising that some alteration in the plan may arise from the form and peculiarities of property and the position of the railway terminus, of which no plans are at present before the public.

Principal shipping entrance.

The right bank of the river, although the width is contracted at the Docking Company's large dock to 600 yards, is, in the neighbourhood of Salt Golah and Howrah Ghat, of a firm and unchangeable character, and there we propose that the principal shipping entrance should be placed with the entrance locks, channel, and basin leading to the floating docks; these latter being situated in the rear of the more valuable property on the river bank.

Area of proposed docks.

It is proposed to excavate (speaking now of the entire plan) two large floating docks of similar dimensions and having an area of 18 acres each, both having a long pier or jetty down the centre, leaving no more vacant space than will suffice for the movement of ships and cargo-boats within.

Entrance gates.

The two docks will open into a basin of 10 acres, the passages being secured by gates; between the basin and the river will be placed the working entrance gates, of which in the principal entrance there will be three sets, making either a long or a short lock. The two outer gates will be double,—that is, having reverse gates which will allow of vessels being locked into the basin, either downwards from high water or upwards from low water; the principal features of the whole scheme being the maintenance of a level in the dock corresponding to the lower high waters of the year, and the exclusion of the muddy waters at the season of the freshes.

Sills of gates.

To carry out this plan will entail a considerable first cost, but as it carries with it the certainty of obtaining a constant supply of water to the docks by permeation through the soil, and as that water will not be charged with any deposit, the advantages which are obtained are merits for which any sacrifice may be made. With this view the sills of all the gates are placed at 19 feet below the lowest high water in the year.

Plans of the Wet-Dock Committee in 1844.

On this point we differ in our plans from all the designs considered by the Wet-Dock Committee in 1846. In the valuable report of that Commission it was clearly stated that the river waters were to be pumped into the dock in an unfiltered condition, that the docks were to be cleared of their deposited mud by scouring, and that the expense of retaining walls of sufficient strength to retain the water was to be a considerable item of the whole estimate.

Natural infiltration.

Retaining walls where placed.

All these calls for outlay will be avoided. Natural infiltration performs the work of steam-engines, and the retaining walls, so absolutely necessary to hold up the water if the level to be used is above the river, are no longer required. It is optional, therefore, to confine walling to the entrances and prominent angles, using open-framed jetties or a lighter description of wall for the dock sides, and permitting the excavated slopes to stand at their greatest safe inclination wherever walled sides may not be called for as quays.

Scouring not necessary.

Scouring, the necessity for which uuder the high-level system appears to have impressed itself so forcibly on the Wet-Dock Committee, is by this plan totally avoided;—not that we wish to countenance the plan of scouring docks at any time, for in practice we believe it to be perfectly ineffectual, if not impossible.

Former plans.

We further differ from the previous plans in that we bring this dock into the centre of business.

Docks at Kidderpore.

The Wet-Dock Committee of 1844 no doubt convinced themselves that on changing their plan from Sankrall to Kidderpore they were adapting themselves better to the wants and conveniences of the community, and we have not the least doubt that had they then had the grounds we now have for preferring Howrah, they would have seen that by a still closer approximation to the anchorage, the godowns, and the bazaars, they would have further increased the utility of the docks—and for the same reasons.

At Diamond Harbour.

Among other past projects for the benefit of Calcutta shipping, was a dock at Diamond Harbour, and a railway thence to Calcutta: this has been long before the public, without meeting with much favour.

The objection to the erection of such large and costly works at so great a distance from the city, the necessity for a town bazaar, steam factories and dockyards to arise in the immediate neighbourhood, and the impracticability of aiding the enterprise by the growth of similar and allied establishments which are already on foot, have always appeared to us fatal to the hopes of this project. Its separation from the present railway system puts it under still further disadvantages. In principle, however, we deny the advantages claimed for this plan and situation and the benefits they were stated to be capable of affording, and find that the Governor General's minute contains, with reference to it, the opinion which all practical seafaring men best acquainted with the navigation and trade of the Hooghly have united in expressing.

Comparative advantages of Hooghly and other channels.

The Mutlah considered as a channel.

The comparative advantages of the course of the Hooghly and the other channels leading towards Calcutta we have more particularly referred to under the nautical section of this memoir; but addressing ourselves here to the general bearing of the question, we are of opinion, from an intimate knowledge of the Mutlah as far as the salt-works, that the insalubrity of the country is of extreme character, the breadth of the rivers small, and the point from which artificial channels must be excavated, either to reach Calcutta or the Hooghly with advantage, far distant. New towns, new lines of trade, fresh warehouses, godowns, and mercantile establishments are not matters to be created in a short time or inaugurated in a day.

Proposed canal in connection with it.

Locked passages necessary.

A canal leading into the Hooghly would, if large enough, allow of great intercourse, facilitate immensely the traffic of native boats, and might even carry shipping to the present anchorages; but such a canal, we know, and speak from experience of many journeys to the eastward, must be made with locked passages to accommodate the different times at which the flood tide reaches by the eastern channels to the vicinity of Calcutta.

General result of such changes.

We may here remark that changes of this character, if small in effect, will hardly reimburse the expense of obtaining them; and if large, will, by rendering unproductive the capital invested in the present system and establishment, so effectually subvert the existing wealth of an established town population as to produce a loss equivalent to the benefit of the change.

NAUTICAL QUESTION.

Character of shipping trading to Bengal; variations in style of ship-building.

Extreme length of steamers combined with moderate draught.

The shipping trading between Great Britain and Bengal has always been of a large and burdensome character. Variations in the style of ship-building have nevertheless led to the navigation of the Hooghly being performed at one time by ships of extreme draught, and in later years by vessels of extreme length. In the latter peculiarity combined with moderate draught, the steamers of the principal companies now trading to the Indian ports exceed all previous forms of construction.

Length of voyage reduced in duration also by the use of steam tugs.

The voyage from England to the Sandheads has been even to sailing vessels greatly reduced in duration, and the all but indispensable use of steam tugs on the Hooghly has wonderfully reduced the time formerly lost in tiding up the river.

Benefit of steam not in the upward voyage.

Deeply-laden vessels homeward bound towed clear on second day, and seldom require more than third day to discharge pilot.

It is not, however, in the upward voyage that the full benefit of steam is shewn. Ships deeply laden for the homeward voyage, which formerly threw away a day at every shoal in the river, are now commonly towed clear of all stoppage on the second day, and seldom require more than a third day (subject to winds) to place them in deep-sea water and discharge their pilot.

Approach to port of Calcutta considered in reference to river navigation and sea channels.

The approach to the port of Calcutta may be considered in two portions: the river navigation and the sea channels, the latter of which may be said to commence at the junction of Channel Creek with the principal stream of the Hooghly above Saugor Island and the Mud Point shoal.

River navigation shoals, and their names.
Character of the James and Mary.

The river navigation, about 60 miles in length, comprises the five shoals at Moyapore and Roypore, the James and Mary, and at Rangafulla, Middle Point, and Mud Point; the Middle Point and Rangafulla shoals being about 5 miles above Mud Point, and the James and Mary about 35 miles below Calcutta. This last is the principal impediment to the free navigation of the Hooghly. It is a moveable quicksand formed at the junction of the Roopnarain and Damooda Rivers which enter the Hooghly at a right angle, and below which that river assumes a more tortuous course.

Delta of the Ganges and Berhampooter. Extent.
Sea-channels.
The Hooghly the only ship channel.

The delta of the Ganges and Berhampooter extends across the head of the Bay of Bengal, 300 miles from the 78th to the 92nd degree of east longitude, divided into some fifteen sea channels,—those of the Ganges and Megna forming the eastern and the Hooghly the western outlet. The latter is the only ship channel used, and extends in a south-south-eastern direction 20 or 30 miles beyond the lowland through the Sandheads or sea reefs.

Soundings.
Balasore Roads. Point Palmyras.

Soundings of 20 fathoms extend 10 or 15 miles outside the reefs, and thence across Balasore Roads, reaching about 60 miles south-west to Point Palmyras, where inward-bound ships meet the pilot vessels in the south-west monsoon, or in their absence obtain good anchorage in the adjoining Balasore Roads.

Outer floating light.
Inner floating light.

The outer floating light-vessel, placed in 9 fathoms at low water, is about 35 miles from land; the inner floating light 25 miles nearer land and in 3½ fathoms.

Pilot Ridge; its extent.
Peculiarity of soundings.

Between the light on False Point and the lower floating light and across Balasore Roads, the Pilot Ridge extends 45 miles, affording such known features as to soundings and bottom as to form a mark towards which ships in the south-west monsoon may steer with safety for a pilot, who, from the peculiarities of the soundings, can cross the tails of the sea reefs, and bear up the channel in perfect confidence of finding the upper floating light, even should the lower light not have been seen.

Western head of Bay of Bengal.
Nature of bottom.
Points of sand from river.
Difficulties of a ship when driven to the eastward.
Course of vessels in south-west monsoon.

In the western part of the head of the Bay of Bengal, an exact knowledge of the nature and material of the bottom is, next to the visible evidence of the light-ships, the best indication obtainable of the position of a ship. The true bottom of the sea is a solid and good holding ground, but where that is overlaid by the points of sand protruding from the river, there is no tenacity in the bottom, and a ship driven among the sands at the head of the Bay, when forced to the eastward of the entrances of the Hooghly, is entangled among difficulties—*first*, from the want of holding ground owing to the prevalence of sand; *secondly*, from the depth of the swatch or no bottom patch in which 120 fathoms water is to be found within 20 miles of the shore; and *thirdly*, from the want of indication, either by the nature of the bottom, the currents, or the shore, of the precise part of the coast she may be on. These and other reasons operate in inducing ships to keep near the western land in the south-west monsoon until a short course across the heads of the two sea-reefs takes them into the fairway of the channel.

Description of sea entrances.
Channel between eastern sea-reef and Saugor Sand now used.

A century since, the principal sea channel followed the western shore as far as Kedgeree; subsequently the western channel between the western and eastern sea-reefs was used, but for the last forty years the channel between the eastern sea-reef and Saugor Sand has been the navigable channel.

Gaspar Sand.
Depth of water at low-water spring tides.

Situated in the middle of this channel, and about 10 miles from Saugor Point, is the Gaspar Sand, which may be considered the present bar of the Hooghly, having the Gaspar Channel on the east and Thornhill's Channel on the west, the best water alternating between them, and sometimes opening a third or eastern channel, at present having 16 feet at low-water spring tides.

Rennel's survey, 1783.

From Rennel's survey, 1783, it appears that there were two ship channels into the Hooghly: one on the right or western bank, the other on the eastern or Saugor Island shore, extending up 20 miles as far as Mud Point, where the river is 4 miles broad.

The centre space was formerly occupied by the Mizen Sand-bank and its continuation, the Long Sand. In 1815 Lloyd's Channel was discovered across the Mizen to Kedgeree.

The channel on the east side of the Mizen gradually closed in the upper part near Mud Point, and was in the lower part used as the new anchorage, where the large Indiamen discharged or completed their cargoes till their withdrawal in 1833.

Lloyd's Channel and Mud Point Channel subject to constant changes.

Lloyd's Channel from Saugor to Kedgeree across the tail of the Mizen Sand, and the Mud Point Channel from Mud Point across the head of the Mizen Sand, have been subject to constant changes, both in position and depth. A large island once formed and again disappeared. The present channels vary in depth over the sand, the least being in Lloyd's Channel, 25½ feet, and at Mud Point 30 feet at high-water neap tides.

Further observations on the shoals in the Hooghly we defer to another part of this paper.

Number of ships entering the Hooghly from 1773 to 1813.

During 40 years, from 1773 to 1813, the number of vessels which entered the Hooghly annually increased from 160 to 294.

Pilot service.

Surveys of Rennel laid down.

Those trading with Europe being exclusively the East India Company's property, were armed and were frequently laden to a draught of 25 feet. At an early period necessity arose for an organised European pilot service; pilot vessels and floating lights were established, and the surveys of Rennel and others were laid down to secure the safer navigation of the river, which extends over 150 miles from Calcutta to the sea-reefs.

Admission of private shipping in 1813 to 1833 which generally loaded off Calcutta.

Difficulties in getting to sea.

Introduction of steam tugs.

From 1813 to 1833 private shipping were admitted to a free trade with India, and the ships entering the Hooghly increased to 372. These (with some exceptions among the East India Company's ships, which remained at the lower anchorages at Saugor and Diamond Harbour) mostly received and discharged their cargoes at Calcutta. Their return to sea laden with produce occupied much time both during the dry season and the south-west monsoon. The necessity of crossing each of the shoals at high water and the uncertainty of tide and wind occasioned detentions of from two to six weeks, to lessen which cargoes were frequently completed from sloops in the lower part of the river, at a great expense of time and money. These difficulties led to the introduction of steam tugs, and by private enterprise in 1829 the *Forbes* and other steam tugs were established; but adequate support not being given these separate enterprises were abandoned at considerable loss.

East India Company relinquish mercantile transactions in 1833; pilot service kept up.

Steam maintained for conveyance of troops.

In 1833 the East India Company relinquished all connection with mercantile transactions and shipping, but the Bengal Government continued the pilot service with their vessels and floating lights; and buoys, boats, and harbour accommodations were arranged under a Master Attendant's department. Several steam-vessels were maintained for the conveyance of troops to the maritime provinces, but were often employed in towing ships on the Hooghly.

Steam Tug Association formed in 1834.

In spring of present year great inconvenience felt by insufficient supply of tug boats.

Increase of shipping since 1833.

In 1834 the Calcutta Steam Tug Association was formed. Their fleet of steamers has varied from 3 to 5 efficient tug vessels during the last 19 years. The competition of other steamers has caused alternate periods of profit and loss, resulting in there being but 7 private steamers available for towing ships in 1853. At that time the Government steam-vessels were absent at Burmah, and great inconvenience was felt from the insufficient supply of tug boats. At the same time the returns of shipping frequenting the Hooghly for the past year show 904 vessels averaging 470 tons, against 372 vessels averaging 371 tons in 1833.

This great increase in number and size since the withdrawal of the East India Company's large Indiamen has brought with it a variation in the style of ship-building, inducing the leading shipowners to build longer vessels of lighter draught of water that would always load off Calcutta. These ships, with the increased supply of tug vessels and also the mail steamers now frequenting the port, find no difficulty in crossing the shoals, as, although of increesed tonnage, their draught of water seldom exceeds 20 feet.

Application by Bengal Chamber of Commerce to Governor General as to silting up of the Hooghly.

In May 1853 the Government of India were informed by the Bengal Chamber of Commerce that

> " during the present season the depth of water on the James and Mary's in Lloyd's Channel and on the Gaspar Sand has been less than ever previously known, and for many weeks past pilots have not felt themselves warranted in moving ships of more than 500 tons burthen without steam, during which time the towing steamers of the port have consequently been so fully employed that many outward bound vessels loaded and ready for sea have been detained from a fortnight to three weeks, unable to proceed on their voyage,"

Submit the Mutlah as a new communication.

Reply by the Governor General.

urging their opinion that these impediments are progressive, inevitable, and that they are beyond the reach of engineering skill. The Bengal Chamber of Commerce further submitted to the consideration of the Governor General the importance of opening a new communication from the sea to Calcutta by means of the Mutlah River, which has at a distance of 25 miles from its mouth a sheltered harbour for vessels of large burthen. The Governor General, Lord Dalhousie, without concurring in these views, has ordered surveys to be made, and a committee to enter into an investigation similar to that made in 1844 on the practicability of providing Calcutta with wet docks.

Observations on these opinions.

We cannot in this paper pass unheeded the opinions that have been thus expressed on the silting up of the Hooghly, and pending the reports of the committee and surveyors, we beg to lay down a few facts bearing on the question which we have gathered from personal experience.

Speaking from 20 years' connection with the navigation of the Hooghly, including practical experience of the capabilities of steam towage on that river, we differ widely from the opinions of the Bengal Chamber of Commerce; and we consider that, although the channels may have gone through many cycles of change, so far from progressive impediments being inevitable, the channels have always returned to their original depth, and that though there is nothing to indicate that the Hooghly is silting up, even should there be some diminution of depth, that may be obviated by a more general employment of steam in towing.

Opinions of Branch Pilots in 1844. Minute by Governor General, April 20th, 1853.

We are borne out in this view by the concurrent opinion of 11 out of 12 Branch Pilots referred to in 1844, and by the minute of Lord Dalhousie, 20th of April 1853, as to the dangers incurred by the trade and shipping in the navigation of the Hooghly, and referring to a return showing that all the vessels that have been lost during the last 20 years amount to only 51 ships.

> " It further appears that among such ships as have taken the now common precaution of being towed by a tug steamer, only one has ever been lost below Diamond Harbour, and not a single one above it."
>
> " Apprehensions have been entertained that the navigation of the river might be closed altogether by the silting up of the channels near the James and Mary Sand. "
>
> " No information has ever been before me to show that this is a probable event, or that it has of late years become more probable. "
>
> " Fleets of magnificent merchant ships annually come and go uninjured, and even unimpeded. The fine steam-ships of the Peninsular and Oriental Company habitually run up and down the river safely and at a very high rate of speed. The large mail steamers of the Screw Company and the heavily-armed steam frigates of the Indian Navy perpetually traverse the channel without difficulty or danger."

Letter by a Branch Pilot, 1853.

Such being the opinion of the authorities on the spot best able to judge, pending the official report, we offer the best evidence obtainable of the present state of the different channels or shoals in the Hooghly from a letter lately published by a Branch Pilot, who states that the tide rises 14 feet in the neaps and 20 feet in the springs, and that in the month of July in the present year there was at the undermentioned places :—

Table of Depths at different Shoals.

	Depth at H. W. Neaps.	Depth at H. W. Springs.
Moyapore	33·0	38·3
Roypore	37·0	42·7
James and Mary's	24·0	29·6
Rungafulla	28·0	33·6
Middle Point	30·0	35·9
Mud Point	31·0	36·6
Auckland Ridge	34·0	39·6
Lloyd's Channel	25·3	30·3
Gaspar Channel	30·0	36·6

Performance by screw steam-ship, Calcutta.

The column of neap tides exhibits the least depth at high water on each shoal for two days each month; the column of spring tides, the greatest depth obtainable every fortnight or spring—sufficient evidence that with steam power the deepest ships now navigated may cross several of them in one tide, as was lately exemplified by the screw steam-ship *Calcutta*, 1,800 tons (?), running from Calcutta to Kedgeree, a distance of 90 miles, in 6 hours on the .

James and Mary Sand.

The James and Mary is perhaps the principal impediment to the free navigation of the Hooghly. This shoal has the peculiarity of sometimes rising with the flood tide, and the difficulty of denoting its position by buoys or fixed marks is such that we believe both delay and danger may be much reduced by more constant examination of the changes and by daily marking the channels by small boats, and in extreme cases in the low-water season, about March, a powerful steam dredging-machine might be employed to open a channel.

Moyapore and Roypore Sands.

The same remarks apply to the Moyapore and Roypore Sands near Calcutta, where a powerful dredger might be usefully employed in maintaining a proper depth at the usual anchorages, as is the custom on the Thames and other rivers.

General observations on the channels in the Hooghly.

It may be observed generally of the channels of the Hooghly that the existence of a strong line of current, whether from the outfall, or in-draft, does not imply that the channel in which it runs is continuous, and in this feature may be summed up all the difficulties, dangers, and delays of Hooghly navigation; two fragments of fair deep-water course being frequently separated by a ridge or bank of a shifting and uncertain character, to find and know the crossing place in which is the principal duty of the pilot and the incessant object of the surveyor.

The banks or crossing places vary in depth, and are common to every known outlet of the Ganges waters. The channels, however, of which in each case they form the bar, as well as the sands controlling the line of channel, are themselves altogether subject to a change of position; and we can refer to substantial authority when we say that in the river mouth on a line between Saugor Point and the Cowcolly shore, the river channel has repeatedly occupied both sides of it, and the sands bearing generally the same name have been at one time continuations of one shoal, and at other times of another from the narrower course above.

Advantages to a ship entering the Hooghly, compared with the disadvantages in entering the Mutlah.

We have before remarked that to a vessel bound to Calcutta there exist between Balasore Roads and the floating lights certain

> "well-known features as to soundings and bottom which form a mark towards which ships in the south-west monsoon may steer with safety for a pilot, who, from the peculiarities of the soundings, can cross the tails of the sea-reefs and bear up channel in perfect confidence of finding the upper floating light, even should the lower light not have been seen."

On the other hand, a vessel wishing to enter the Mutlah River between the Mutlah and Bulchering Sands would have in the south-west monsoon to run 30 miles to leeward and to cross the tails of the Saugor Sand, the Light-house Sand, and the Bulchering Sand, while from the absence of the peculiarities of the bottom there would be no sufficient guide to indicate the ship's position opposite the numerous channels extending to the eastward, most of which, and particularly the Mutlah, have a bar or shoal between the reefs, similar to that found by the Gaspar Sand between the Eastern Sea-reef and Saugor Sand.

Correct longitude necessary.

It should also be remembered that to the sailor the navigation is one entirely of longitude, not easily attainable at the end of a voyage with a doubtful knowledge of the latitude and a frequent prevalence of thick weather.

Navigation of the Mutlah.

Shoal similar to James and Mary.

With respect to the navigation of the Mutlah, we have, from the infrequency of navigators visiting it, less opportunities for speaking with certainty; but it may be observed that above the safe anchorage in the Mutlah it divides into two branches, one at right angles with its course, which being joined by other channels, a shoal is formed in the middle of the stream similar to the James and Mary.

It appears from Captain Lloyd's survey that there was a navigable channel, 25 miles above the anchorage, to Matee, from whence there is a boat communication with Calcutta through Tolly's Nullah.

Scheme for communicating with Mutlah anchorage.

On the schemes for constructing a railway or ship canal for the transport of goods to the ships at anchorage, we shall here offer no comment further than to compare the relative economy of time and money and facilities afforded to shipping by continuing to use the Hooghly, or transferring its commerce to the Mutlah and re-transporting goods, of which a vast quantity must arrive from the interior by railway to Howrah, either by water or land carriage to Matee.

Similarity of the port of Liverpool with the Hooghly:

We know of no port showing greater similarity to the entrance of the Hooghly than that of Liverpool, where the great force of efflux due to the high tides and the narrow entrance produces the same effects as the great internal supply of fresh water in the Hooghly.

in small depth of water at neap tides:

There is only 11 feet at low water and 30 feet at high water neap tides on the bar of the port of Liverpool, notwithstanding which the largest ships and steamers now afloat enter the river without difficulty or delay when steam towage is resorted to.

in changes in channels.

As to changes, the Hooghly resembles the entrance of the Mersey in the fact that the Mersey formerly had a channel along the left bank down to Hoylake, and another, the Crosby Channel, on the right bank, with the Burbo Jordan and other sand-banks between.

These two channels having varied considerably, the best water is now found across the former shoals or Jordan flats. The changes, however, are so great and constant as to require daily alterations in the buoying and lighting by the Marine Surveyor. But the difficulties of entering channel through reefs is greatly reduced at Liverpool by the proximity of land lights and buoys; while on the Hooghly the sea-reefs and channels reach 40 miles outside the low lands with only two floating lights and one light-house extending over 90 miles in a north-east direction, the dangers arising from which have this result, that out of 51 vessels lost in the last 20 years, 35 have been lost below Mud Point, where the river navigation begins. To a parallel point on the Mutlah the land and sea channels extend 30 miles further on a lee shore in the south-west monsoon, which with the increased risk would require more floating lights, buoys, and pilot establishment, the expense of which is already so much complained of by the ship-owners.

From these facts it is evident that a transfer of the shipping and trade from the Hooghly to the Mutlah would cause no diminution of the sea risk, costs, or delay in navigating the sea channels of the Port of Calcutta, the natural difficulties causing delay in the north-east monsoon and danger in the south-west monsoon.

Notwithstanding the difficult entrance to the port of Liverpool since the introduction of railways in 1830, the shipping entering the Mersey have increased from 11,214 vessels, aggregating 1,411,964 tons in 1830 to vessels, making 3 in 1853, and the dock accommodation from 70 acres area to 210 acres, with extensive graving docks, warehouses, &c., afforded at an outlay of five millions. Yet such have been the exigencies of increased trade that further dock accommodation has been undertaken at Birkenhead, on the opposite shore of the Mersey, and in competition with the Liverpool docks. Into these docks, although but partially completed with one pair of gates, an amount of tonnage has been received nearly equal to the shipping entering the Hooghly.

The works in course of construction comprise one dock of 140 acres, with a low-water basin of 30 acres, connected with gates and locks 100 feet wide and 500 feet long, to receive the very large ships, and require an outlay of one million sterling.

We do not deny to the eastern Soonderbund River, Tolly's Nullah, and the Salt Lake the capability of great improvement, and consider that the eastern trade will be greatly assisted by an additional outlet into the Hooghly; but we strongly urge the principle which has guided us throughout, that the Hooghly is the most obvious and certain high-road between Calcutta and the sea, that it is capable of great improvement both in its channel and nautical resources, and the position that will give to docks the greatest practical value will be the one that places them immediately between the railroad and the river, without making them dependent on, or depriving them of, the accessory advantages to be derived from other more speculative but desirable improvements.

HOOGHLY BRIDGE.

Necessity for a bridge.

To connect the shores of the Hooghly by a bridge has long been a desirable project, and one for which the necessity now becomes urgent.

Former proposals for a floating bridge.

The use of floating bridges as a means of effecting the transit has already received considerable public attention, and in the years 1840 and 1841 a company was formed with the express object of carrying out a ferry on that system between the two shores of the Hooghly. The particular circumstances which led to the failure and dissolution of that company having been entirely dependent on commercial affairs, do not now demand explanation ; we may, however, state that no physical or engineering difficulties prevented the realization of the scheme.

Present design.

Mr. Greaves having been engaged as resident under Mr. Rendel, the eminent engineer in the designing and superintendence of the vessels and machinery for that company, and also in other similar works in this country at Devonport and Portsmouth, and having subsequently proceeded to Calcutta to establish the floating bridge there, a well-founded knowledge of the subject thus obtained induces us to propose the following design for the establishment of a steam or floating bridge between the docks and the city of Calcutta.

Its advantages to the proposed docks.

The docks as now proposed to be constructed are absolutely far nearer to the heart of the city, the Custom House, and merchants' offices, than they would be if constructed in any other available situation.

Taking the Calcutta Custom House as a centre, the proposed docks are only 1,500 yards distant from it, the docks proposed by the Wet-Dock Committee being at a distance of three and a half miles, and the prior schemes at Akra farm and elsewhere were situate at points still more remote.

The most proximate position—*viz.*, at Kidderpore—entailed the construction of a railway three and a half miles in length, the peculiar details of which are commented on in an amusing and instructive letter which forms the Appendix to the Wet-Dock Committee's Report, 1844.

Comparison with a fixed bridge.

The substitute for this railway in the plan now submitted is the steam bridge connecting the two banks of the Hooghly—a work highly desirable in itself, eminently feasible in its execution, and within the compass of a cost which will be more than defrayed by very moderate tolls on the daily traffic, affording in many particulars a more desirable route for that traffic than any permanent and immoveable structure.

That the trade which the railway is expected so largely to develope will be dependent on the native hackeries for the ultimate removal of goods to the merchants' godowns we presume to be inevitable under any probable state of affairs in Calcutta. The route from shore to shore *viâ* the floating bridge will present a level and uniform course, short in distance and moderate in cost. No fixed bridges, unless made on a principle which would sacrifice the advantages of a noble, river could be at a level less than 100 feet above the water surface, to reach which a circuitous route, a long and tortuous inclination, and a toll commensurate with the enormous cost of such a structure, would be unavoidable. The ascending incline could not be less than half a mile, thereby entailing a journey more than quadrupled in length alone on goods moving from shore to shore—a proceeding which would afford no alleviation to the present difficulties of boat traffic.

Origin of floating bridges.

The completion of the steam ferry in 1834 over the Tamar at Torpoint first introduced this method of transit to the notice of the public, since when the establishment of a similar conveyance across the Itchen River in 1836 and across Portsmouth Harbour in 1849 have fully proved this to be, as was then first asserted, the most certain, most regular, and most economical method of working ferries across tidal estuaries or broad rivers.

Statement of fitness generally.

Method of working described.

The method in which peculiar advantages of the floating-bridge system are attained may be perhaps best explained by referring to a paper contributed by Mr. Rendel to the Institution of Civil Engineers in 1838 and published in the Transactions of that society. He there states that, "by employing the chains as a guide from shore to shore, the passenger by the bridge is rendered safe by night as well as by day, and in rough weather as in fine; whilst by employing them as a medium through which motion is conveyed to the bridge, a command is obtained which enables the man at the engines to start, stop, and move forward or back with a certainty and rapidity unattainable by any other means.

'These advantages are found of the utmost value in approaching the landing-places, the chains acting better than any warps, &c.

"By their employment the course is direct, the speed uniform, and may be maintained with safety to the shore approached, and the delay or backing, warping, &c., which in some ferries take as much time as crossing the river, is entirely got rid of."

Particular success at Devonport and Portsmouth.

The position of the two ferries at Devonport and Portsmouth in the midst of the naval and mercantile shipping in close proximity to the dockyards, gun, wharf, and steam departments of the respective ports, is sufficient proof that a ferry worked on these principles presents no obstruction to the navigation, whilst its unceasing regularity, immunity from danger, and uniform increase of traffic prove that it suffers no obstruction from the numerous shipping and constantly-passing small vessels of those crowded ports.

Immunity from accident.

This immunity from accident and stoppage so excellently obtained in the two last-named ferries, affords the best assurance of equal success on the line here propesed; neither is the width of the river and consequent length of the chains at all greater than the Torpoint or Portsmouth ferry, so that this objection, which might have had some weight in the case of rivers of extreme width, in this case without application, and the more so as it has been proved of no account in those ferries, although coupled with the fact of their being large shipping ports and the site of constant anchorage.

Economy in working.

Economy in working is a point no less favourable to the comparison of this method of crossing rivers with that of free or paddle steamers, in proof of which we may cite the evidence given before a Committee of the House of Commons in 1843 in favour of a Bill brought in by the Exchequer Loan Commissioners for establishing a floating bridge at Dundee, in which it was shown that although the traffic at Portsmouth was quadruple that of Tay ferries, the cost per hour of working was one-third and per mile one-half that of the free-steamer system. This economy arises from the fact of the bridge being as nearly as can be self-acting, requiring consequently but few hands, and reversing, stopping, raising, and lowering her gangways entirely from on board, by which means all concussion and damage is avoided, and wear and tear is reduced to a minimum.

We are enabled by the liberality of the proprietors of the ferries enumerated below to give the following table of the expenditure in maintaining their respective establishments,—many years' experience being now available in proof of their economy :—

ANNUAL EXPENDITURE.

Expenditure of existing companies,

	Torpoint. Average of 5 Years.			Itchen. 7 Years.			Portsmouth. 4 Years.		
	£	s.	d.	£	s.	d.	£	s.	d.
Management	47	18	2	922	7	8	202	11	2
Maintenance	593	12	5				1,094	2	3
Repairs	234	8	8	350	0	0	345	17	½
Depreciation of chains . .	142	6	8				150	0	0
	1,018	5	11	1,272	17	8	1,792	10	6

ANNUAL INCOME.

and their annual income.

	Torpoint.	Itchen.	Portsmouth.
1829-30. Ordinary ferry boats .	1,014 0 0		
1833-34.	930 0 0		
Steam bridge opened	1834	1836	1840
			1844-45
1837-38. Tolls farmed at . .	2,000 0 0	average for 7 years	3,554 17 4
1846-47. Ditto . . .	2,571 18 7	ending 1848.	1847-48.
1847-48. Ditto . . .	2,670 0 0	2,358 0 0	4,434 10 8

Accidents have occurred.

It is not to be denied that in the bridges now in use the chains have occasionally broken either from original weakness or from reduction of strength by wear and tear; but although it has been the custom at Torpoint to continue working the remainder of the day on one chain, it has never happened that both chains have broken at once, and one chain has always sufficed to work the bridge for the repairs and relaying of the other, it being always provided in the original construction that one chain should be sufficient to ride the bridge in any tide that runs in its locality.

Current in the Hooghly.

The rise and fall of tide in the Hooghly at Calcutta is 12 feet 6 inches, the rise of the freshes about 6 feet, and the extreme range about 18 feet 6 inches. The current may run about 7 miles per hour, the ebb stream being by far the most violent during the freshes.

The rapidity of the current at Portsmouth is quite sufficient to establish the feasibility of the principle in other tide-ways, and notwithstanding the landing-places at Portsmouth, were cramped to an inconvenient size by opposing parties; the ease and convenience with which the ferry has been worked indicate plainly what might be done when ample accommodation for the sweep of the tide can be provided, as in the great ferry for which it is now proposed.

Provision for security.

The only provision we consider necessary to secure the full development of this method of communication, is that the shipping should by authority be prevented from occupying that part of the usual anchorage lying within the sweep of the chain, and that it should be exclusively appropriated to the traverse of the bridges.

Estimate for proposed bridge.

The whole estimate for the erection of a floating bridge establishment with duplicate boats and chains and landing-places sufficient for both is £40,000, and a moderate computation of the income induces us to believe that the whole may be maintained in working order for half-hourly journeys at a charge of 50 per cent. on the probable revenue.

Indirect advantages.

Independently of its connection with the present scheme, as an auxiliary means of promoting that convenience of intercourse, that accommodation to the trading community, and that inducement to the production and consumption of the staple articles both of export and import in this great country, for which the Honourable Company have already expended so much in the opening of lines of communication, and especially in the construction and improvement of the Great North-West Road, we can conceive nothing more effectual than thus closing an hiatus in the great artery of communication, the importance of which in the present state of our relations with the Indian Empire few can fail to appreciate.

COMMERCIAL QUESTION.

Calcutta as a port.

As a port, Calcutta may rank high among the great ports of the world.

Tonnage frequenting it.

The total annual tonnage is not less than 400,000 tons, and the whole of it, as currently entered and reported, is a *bonâ fide* trade and not a mere registry of passing vessels.

Mixed character of its trade.

The trade of the port, however, is of a mixed character, a very large proportion being carried on with Europe, and principally with the United Kingdom, while a considerable tonnage represents the commerce circulating among the Asiatic ports locally known as the country trade.

Shipping by whom carried on.

This trade was formerly very much carried on in vessels owned by British merchants in Calcutta. The existing owners of shipping are now a few Arab traders whose vessels, mostly purchased from former English owners, are occupied in trade between Bengal and the ports of the Persian Gulf, the coasts of Arabia, Malabar, and Mauritius, and the cotton trade between Bombay and China, the more valuable and opium trade being carried on by steamers and American shipping.

Country trade.

The country trade with the eastern ports of the Archipelago has of late years passed greatly into the hands of German shipowners belonging to the Northern and Baltic ports, Bremen, Hamburgh, &c., whose vessels, remaining in those parts for two or three years, have now absorbed much of this business to the exclusion of British. The number of American ships has greatly augmented, and the foreign Europe traders form no inconsiderable body, but the bulk of the shipping and the most valuable and important freights are those for the United Kingdom.

Difference in amounts of goods carried out and home.

With the Europe traders there is a great difference in the amount of goods carried out and home. The freight to India is of manufactured goods and homewards of unmanufactured, and raw materials greatly exceeding the former in tonnage.

Length of voyage.

The voyage is very generally made out and home in the year, but ships have occasionally been taken three times from port to port in one twelvemonth. The time for discharging and loading cargo is never less than a month, and in the estimates furnished by the Calcutta Chamber of Commerce to the Wet-Dock Committee, 1844, is stated to be 45 days. While in port, ships are either placed in fixed (all four) moorings near the shore, or lie at swinging moorings in the stream; they are also as frequently moored with their own anchors, but in either case, from the absence of quays, goods are taken on board in the stream. Watering is performed in the same way, and repairs, unless sufficiently large to send a vessel into dock, are performed at a ruinous cost by sending men and materials to perform them at a distance from the dockyards on shore.

Character of ships.

The shipping employed in this trade has always been a boast of the British shipowner, nor is it possible that any port in the globe can exhibit such an array of first-class merchantmen, and in such condition as may be seen in this port in the cold season, ranged generally in three tiers through the principal part of the river, and kept as if for inspection or review in a condition most attractive to the homeward-bound passenger.

Internal trade.

Country-boat dock.

The magnitude of the internal trade of Bengal, the immense capital and population employed in the river craft, and for the transport not only of the merchandise arriving and departing with the Europe, foreign and country traders, but of that endless stream of articles for the food, use, and manufactures of the teeming population is but little known beyond the limits of Calcutta; and in justification of our proposal to provide a boat-dock as accommodation to that increasing business, we will quote first from the *Calcutta Review*, June 1847 :—

> "Nearly all the commerce between India and Europe has but two great emporia, Bombay and Calcutta: one for the western and the other for the eastern side of India, which together receive the wealth of a continent whose dimensions must be described by hundreds of thousands of square miles, whose geology presents every variety of feature, and which, besides its peculiar and purely indigenous products, is capable of producing on hill, valley or plain, on some diversity of its length and breadth, almost anything which any other country produces: of edibles, tea, coffee, sugar, saltpetre, rice, wheat, and other grains and seeds in uncounted variety, food for man and beast, which would make the poor at home envy even our horses; of raw materials for textile and other manufactures, silk, cotton, hemp, flax, jute, caoutchouc, horns and hides; of dyes, indigo, shellac, lac dye, cochineal, &c.; oils in great variety; of gums in great variety, copal, Arabic, myrrh, &c.; of drugs and medicines, besides opium and tobacco, a rich but little known pharmacopœia; woods; stones of great beauty, including marble, besides coal, iron, and unexplored mineral treasures. India also has its manufactures; Dacca its muslins; Murshedabad its silk; Patna its candles and cloths of all descriptions; Mirzapore its carpets, rugs, blankets; Benares its embroidered cloths, shoes, and a variety of other articles; Delhi and Kashmere its shawls and jewellery; Gujrat, in the Punjab, its damascene blades, and almost every district some branch of industry—the object of a commerce capable of vast increase, if better means of transit were afforded."

Robinson on the trade of the Ganges and Hooghly.

With respect to the traffic on the river from Calcutta upwards, we are able to extract some remarks bearing on the subject from a pamphlet published by Mr. Albert Robinson, C.E., who in 1843 carefully surveyed the Ganges from Allahabad downwards, and subsequently established steamers on that river :—

Impediments to the navigation of the Ganges yet still available.

> "Notwithstanding all the impediments which Nature has placed in the way of the navigation of the Ganges in the low water or dry season, it is still even then available for carrying on the traffic of the country to an extent that the resources of science and capital would find it no easy task to provide a substitute for.

Jungeepore Toll.
Number of vessels passing.

> "At the Jungeepore Toll on the Bagheeruttee, the only point, except Calcutta, where there is any return made, the number of these vessels which passed was, in the year 1844, 50,320 boats, the tonnage of which was upwards of three quarters of a million.
>
> "The articles enumerated consisted of grain, pulse, salt, sugar, indigo, cotton, saltpetre, oil-seeds, mangoes, vegetables, coals, lime, firewood, straw, &c. In the above no account is taken of vessels with Government stores, troops, ammunition, &c., nor of opium.
>
> "The number of river craft arriving at Calcutta by the Soonderbund rivers upon which toll was collected amounted in 1844 to 125,000 boats, or an average of 340 boats per day, the total tonnage of which is about 1,250,000 tons. The traffic at these two points alone added together (which it is fair to do) amount to upwards of 2,000,000 tons, or four times as much as the whole sea traffic in ships to and from Calcutta. No account was taken of boats under 28 maunds.

Return of Government Steam Department.

> "The returns from the Government Inland Steam Department in the same year (1844) gave 39 voyages, carrying 45,500 packages of goods, besides treasure, and 2,500 passengers, and show a return of upwards of £56,000.

Trade from Mirzapore down the Ganges.

> "From Mirzapore, a great mart of the Ganges, it is reckoned that 18,000 tons of cotton, 2,000 tons of sugar, 1,000 tons of saltpetre, 1,500 tons of indigo, and 1,300 tons of shelllac and lac dye, are annually sent down to Calcutta; whilst there is received at Mirzapore from Calcutta yearly 8,000 tons of metal and hardware, 5,000 bales of twist, 3,000 packages British silk and cotton goods, and 10,000 packages of other piece-goods."

Effect of railway.

It may be suggested that the greater or part of these goods will be eventually carried by railway, and that the boat traffic will be diminished in proportion, but in England we find in many instances that canals placed in competition with railways are carrying more goods than before the latter existed.

Such has been the expansion of commerce in Great Britain, and we may suppose that it will be only in less degree in British India.

Direct advantages of docks. Saving to shipowner.

Amongst the real tangible advantages which the existence of wet docks offers to the trade of a port is the saving in expenses falling direct on the shipowner.

Wet-Dock Committee, 1844, on the subject.

The Wet-Dock Committee, 1844, was furnished by Messrs. Massey and Beckwith, of Calcutta, with detailed accounts, from which it appeared that a vessel of 400 tons is, on an average, 45 days in port, and that such a vessel would load and unload in the docks in about three weeks, and that her expenses would be R33 per day, including wages and provisions. Other costs and charges are added, making the total, including insurance against the river risk, amount in all to R68. By a saving of 20 days this becomes R1,360 per ship, but allowing that some dock charges would have to be borne as a set-off, the simple reduction of expenses in port will be found scarcely less than R1,000, or £100, per ship; and as we have elsewhere quoted the number of ships which we may anticipate using the docks at 400 per annum, we find a diminution of annual disbursements of £40,000.

Wet docks of London.

Opinion by Mr. Vaughan, their promoter.

At the close of the last century, when the construction of wet docks in London was so ably advocated by Mr. Vaughan, he states that "the docks would treble the despatch given at the legal quays, and also the convenience flowing from them. They would be central to the city, to the customs, to the excise, to merchants, tradesmen, brokers, coopers; also to inspection, rule, delivery, and consumption. They would not disturb the present seat of commerce or the situation of manufactures near the landing of those merchandizes that are large and bulky."

Comparison with Calcutta.

Mutatis mutandis, this may be equally said of Calcutta, and if true of a port in which there were quays, how much more so where there are none.

Losses to merchants by pilfering under present system.

M'Culloch.

The losses which are annually inflicted on merchants and traders by open and concealed robbery are too well known in Calcutta to make it necessary to explain here how the value of goods is raised, not only by the loss of what is stolen, but by the charges for watching every boat-load of goods sent alongside a ship. In London and the greater British ports, docks have been now long enough in existence to make the reader almost wonder at the estimate given by M'Culloch that "previously to the construction of wet docks on the Thames, the property annually pillaged from ships amounted to £50,000 a year, although he at the same time qualifies his statement by the remark that this was probably an exaggeration."

Vaughan on the same.

And yet we find Mr. Vaughan states that

"calculations have been made of the annual losses by plunderage to the West India produce alone of above £150,000 per annum to the proprietors, and of £50,000 per annum to the revenue for the port of London, and if other branches of commerce were included, it might be estimated at a loss of near £250,000 per annum."

Wet-Dock Committee.

The Wet-Dock Committee observe on the question of pillage and the above statement by M'Culloch, that although £500,000 may be a trifle exaggerated, it may serve as a guide to a very rough estimate of the loss from the same source in this (the Hooghly) river. The West India Docks, which were the first completed on the banks of the Thames, were partially opened in 1802. The total value of imports and exports immediately before that year the Committee have not been able to ascertain, but in 1806, the year after the London Docks were finished, that value (official) was £36,527,000, but it would probably have been considerably less for 1801; taking it, however, to have been the same, and the amount of pillage to have been £500,000, this sum is rather more than 1¼ per cent. on the total value of the exports and imports.

If, then, it was even supposed that such a loss as 1¼ per cent. was sustained from pilfering on the Thames, where there is a well-organised river police, it seems safe to assume 1 per cent. for the calculation of the amount of pilfering on the Hooghly, where the very men employed to protect property are found to plunder it, in those few instances where detection takes place.

It appears, then, by the returns before the Committee, that the average annual value of the exports and imports of Calcutta for the three years 1841-42, 1842-43, and 1843-44 was R14,59,47,196, less opium and treasure not so liable to plunder, R10,27,47,196, on which 1 per cent is R10,29,472.

The sum is enormous, and may possibly be considerably in excess of the reality, but there can be no doubt that the actual extent of depredation is very great.

Absence of vested interests.

In Calcutta there are no vested rights in legal quays, sufferance wharves, or places entitled by ancient usage to exclusive custom-house privileges or priority.

Rights of natives. Particular ghats.

The right questionably held by many natives to demand toll on goods landed at particular ghats may be equally levied (if legal) on what may in future come there, but there is no exclusive right to compel landing in any part of the river.

Bonded warehousing not largely practised.

Bonded Warehouse Company.

The system of bonding has not been largely practised in Calcutta, and not at all to the extent that a proper condition of commerce would justify. The Bonded Warehouse Company, established in 1833, built a handsome and commodious warehouse, which has, we believe, been well filled and has proved a remunerative speculation for some years past. With this there can be no desire to interfere, but the construction of others in greater proximity to the docking quays will doubtless speedily arise from the improved arrangements without interfering with the progress of this solitary instance of the spirit of commercial enterprise.

Navigable space near Calcutta limited.

Among other reasons which induce us to urge the formation of docks at this time is the greatly increasing state of trade. The port of Calcutta will always be limited by the position of the Goosery Sand above it and the Garden Reach shallow below, and within this distance the western shore from the proposed dock entrances downwards, is encroaching on the river by continued deposit, so as to make it quite inadvisable, if not impossible, to form any extent of wharfage there.

Insufficient for increased trade.

The growth of Seebpore island has taken place within the memory of people now in the town, and the whole may again be as capriciously removed. The dimensions available for the increased traffic of ships and country boats is consequently limited, and although the latter may be reduced in number by the competition of the railroad, the general extension of trade will at least multiply the former, if it does not produce an increase of both.

The ground in the rear of the Howrah shore, when formed into floating docks, will be an addition of so much water space to the navigable capacity of a port which must perforce enjoy the whole export trade of the valley of the Ganges and probably of the Berhampooter.

Native boats.

Eastern Canals; their success.

Every resident in Calcutta is accustomed to the crowd of native boats which line the shores of the native part of the town. Even in the Eastern Canals, through which but a limited portion of trade comes to market, the throng is perfectly overpowering. The success of this canal was indeed so great that, within a few years of its completion, the whole expense of forming it was defrayed by the increased value at which the borders were disposed of and the receipts from regular trade.

Indirect advantages.

Anticipating the most complete success for a scheme wisely and prudently carried out, we cannot but point out some indirect advantages which will result from the site here recommended.

Benefits from raising the present surface of land.

Improved drainage.

The general low level of the land in Bengal will of course suggest the benefits to be derived by a general raising of the surface from the dock excavations. A site for the deposit of the refuse or spoil could certainly not be found within the limits of Calcutta, or even of Garden Reach, should that side of the river ever be looked upon as a desirable position; but on the Howrah shore, as yet only partially built upon, and not having acquired the density of a town, a general raising of all the land in the neighbourhood would be the greatest benefit that could be conferred upon it, and a system of drainage would thereby become available as accessory to a general supervision of roads, houses, dwellings, and those sanitary conditions which the promiscuous and unregulated growth of Calcutta permitted to pass unheeded.

The noxious influences of the Salt Water Lake on the east of Calcutta have been too long felt and too frequently reported on to need any recapitulation here. The worst inundations that can happen on the west side of the river will be caused by fresh water, and they may be so economically neutralised by the process here proposed that the pecuniary benefits thereby arising might fairly be thrown into the scale.

We have, however (to avoid introducing anything chargeable with a visionary character), preferred to place the enterprise on its *bonâ fide* merits.

Existing docks.

The number of dry docks or graving docks available for merchant shipping is ten; of these, three belong to the Howrah Docking Company, one to Topp & Co.; the old patent slip and dock; Walker's Dock, the Mackenzie new Dock, Reeve's Dock, Reid's Dock, and Reeves' patent slip. The three Government Docks at Kidderpore are considered as fully occupied by their own works.

Of the above graving docks, several are of very capacious dimensions, and have been employed in docking the largest vessels that have navigated the Hooghly.

The first dock at Howrah was commenced and completed early in the present century, and the last of the above series was finished in 1847 or 1848. The increase of the dimensions of steamers, and the still larger dimensions talked of as probable, make it now necessary that some better method than that now available for entering these grawving docks should be added to the existing accommodation of the port.

Advantage of entering graving docks from still water.

The convenience afforded in entering a graving dock from still water instead of from a rapid current is great and thoroughly appreciated by all practically in charge of such duties.

Greater responsibility not overlooked.

Danger of bore avoided.

Less time required for docking vessels.

The greater responsibility arising from the dependence of all the graving docks with inner entrances on the one principal entrance we do not overlook, but that once duly provided for to ships once within the entrance, the benefits of graving docks accessible from the float will be exceedingly opportune as security from the danger which so constantly arises from the peculiar habit of the tide in running strong flood up the river until a considerable perpendicular fall has taken place by the shore. The floating and dry docks will mutually assist each other, leaving at the same time ample trade for the full employment of the present river-side docks with vessels to which they are best suited; while the immunity from casualties and freedom from the ever-recurring accumulation of mud in the mouths of the present numerous river-side entrances will permit docks with inner entrances to be constructed and worked at a reduced cost, and the power of filling from the float and emptying into the tide will enable them to take in and discharge many vessels in a day—an operation for which two tides are now obviously required.

DETAILS OF PLAN.

DIMENSIONS.

	Length. Feet.	Breadth. Feet.
Outer lock	200	80
Inner lock	300	80
Making a total length of lock of 500 feet.		
Entrance to basin	500	120
Basin	1,000	400
Floating dock, export	2,500	400
Ditto ditto, import	2,500	400
Each having a middle pier or jetty 200 feet long by 100 feet broad.		

CAPACITY OF SHIP DOCK.

	Acres.
Basin (without entrances)	10
Export dock	18
Import dock	18
Total of Land	138½

COUNTRY-BOAT DOCK.

Dock	57
Total of Land	98

In docks close packed there is room for about 9 ships per acre. The docks of 18 acres each would therefore hold 162 ships if full, but allowing one-third of the space for ingress, egress, barges and movement, we have space for 108 vessels averaging 150 feet by 40 feet; two-thirds of this number, or 72 ships in each dock, will have clear berths at the quays.

The basins to be more peculiarly appropriated to the use of steamers will contain at least twelve first-class steam-ships, without interfering with the shipping moving to and from the inner docks.

The amount of tonnage or native craft that may stow in the country-boat dock cannot be so readily defined; a portion, however, of the space and shore will be appropriated to the inland steam trade and transhipment of country coal.

ESTIMATES.

[*Estimates have been prepared in detail, but as any plan must be subject to considerable modification, the several heads only are given as showing the relative cost of the several departments.*]

	£
Exterior boundary wall with suitable entrances for protection and control . .	7,500
Swing bridge over several entrance passages for one main line of road . . .	6,000
Houses, offices, store-sheds, police stations, and general conveniences for the establishment	5,000
Cranes and moorings	7,000
Elevated reservior to be filled by pumping-engines working from the river, with provision for supply of water for ships, fire, washing, cleaning, and general use .	27,500
Railways for transport of goods within the docks, with turntables, sidings, and plant	10,000
Import dock, export dock, basin entrances, locks, gear, quay wall, excavation and removal*	247,000
Boat dock, excavation, slope, entrances, locks, walls, gates, and gear* . . .	60,000
Management and expense of undertaking until commencement of receipts . .	30,000
Warehouses of great capacity with covered sheds and stores for weighing, sampling re-packing, or retaining in bond	100,000
Floating bridge consisting of two steam-vessels on independent chains, chain mooring, and balance weights, landing-places, and entrances	40,000
Graving docks for general business situated within the docks and adapted for large steamers as well as small craft, with gates, pumps, and fixed apparatus . .	60,000
TOTAL .	600,000

The three latter items are works on which the income and dividend must be calculated distinct from the dock estimates. There is consequently only £400,000 of capital, on which, as the main question, it is necessary to see whether an adequate return can be obtained.

SHAREHOLDERS' QUESTION.

Amount of estimate.

In a previous page we have given estimates, of which that of 40 lacs of rupees or £400,000 for the complete docks, we shall here assume, and now proceed to show how the revenue is to be raised, with the cost of management, maintenance, and depreciation.

Expenses of management.

Under the first head we have—

	£
Board of Directors in England	1,500
Secretary	500
Manager and Chief Clerk in Calcutta	1,000
Accountant and Staff	1,000
Engineer	1,000
Dock Master	400
Three Assistants	450
Dock gatemen (natives)	150
Hawser men	100
Diver and sill cleaners	100
Dredging, cleansing, and washing	100
Watchmen, gatekeepers	500
	6,800
Annual damage and repairs	1,000
Annual depreciation, renewals, &c.	1,000
	8,800
Sundry expenses	1,200
TOTAL .	10,000

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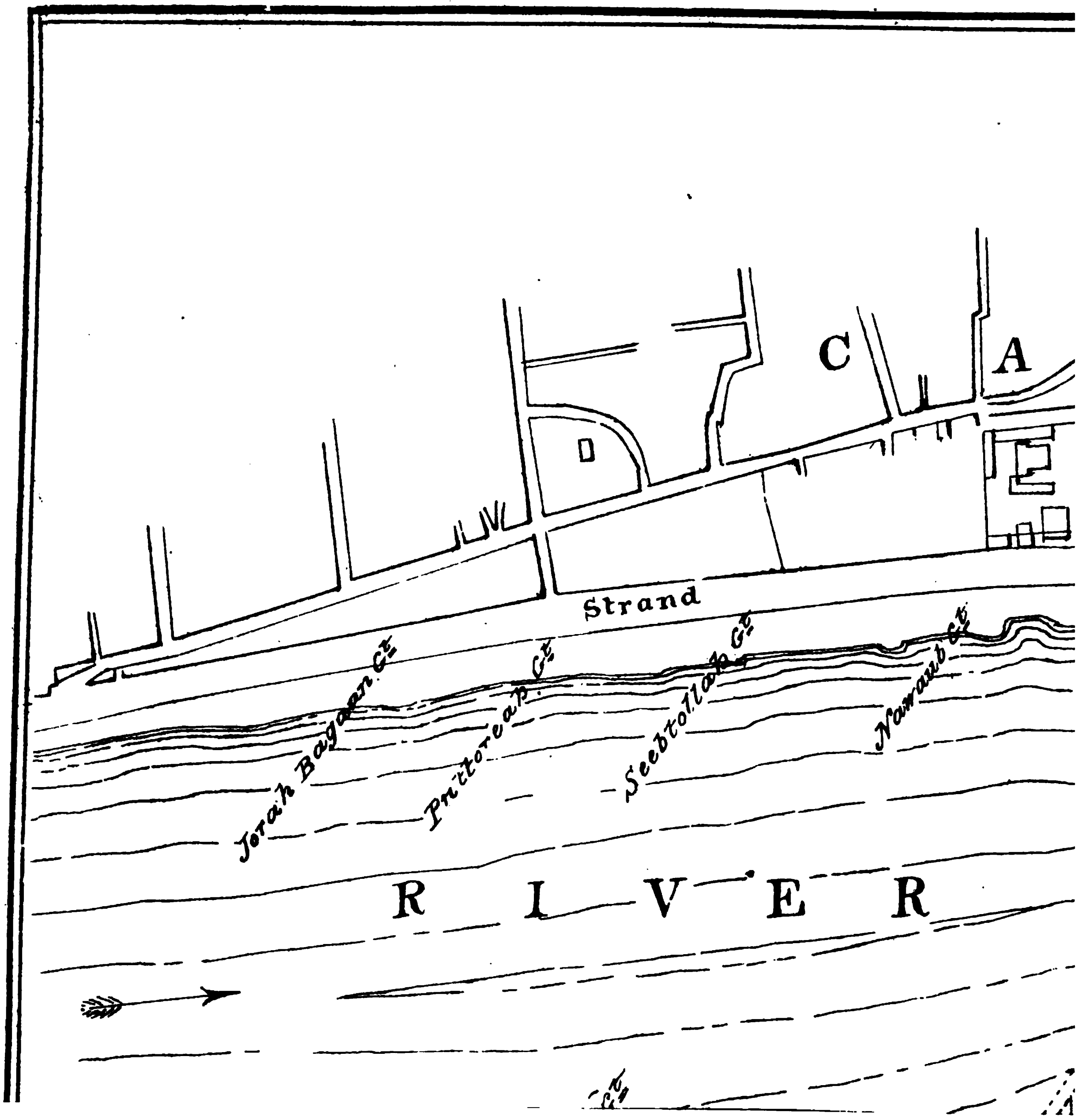
* Inclusive of land as on previous page.


C
A
D
Strand
Jorah Bagaun Gt.
Prittoreah Gt.
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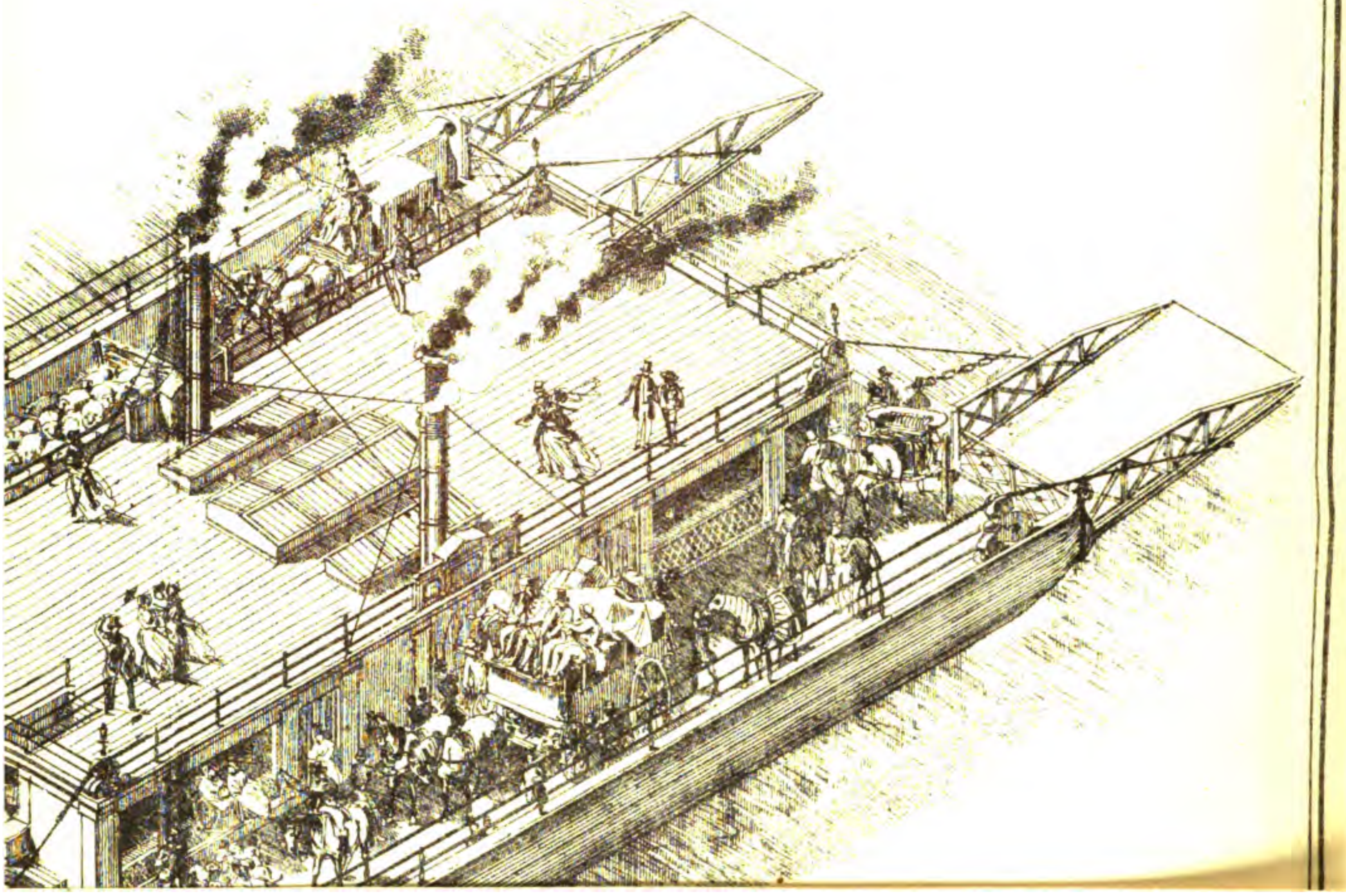
Nawaub Gt.
R I V E R

OF STEAM BRIDGE IN TRANSIT.



Revenue derivable.

In estimating the revenue derivable, we take 220,000 tons of shipping as a probable proportion likely to make use of the docks on the proposed rates, and solely from interested motives, without any preferential or compulsory enactments.

Our revenue will then be—

	R
Ships, 200,000 tons, British, @ R 1	2,00,000
„ 20,000 „ Foreign, @ „ 2	40,000
Goods inwards—	
40,000 tons, British, @ 12 annas	3,39,750
40,000 packages, @ 8 „	
10,000 tons Foreign, @ 20 „	
10,000 packages, @ 12 „	
Goods outwards—	
180,000 tons, British, @ R1	
60,000 „ Foreign, @ „ 1½	
Total Revenue	5,79,750

Gross revenue, exclusive of warehousing, watering, &c.

We thus have a sum of R5,79,750, exclusive of any revenue which may be derived from warehousing, watering, overtime, cranage, porterage, &c., all of which are here excluded as intended to be borne on their own special account independently of the dock estimates; but as it requires no special showing to prove that all these operations can be worked at a profit, their addition to the general plan is left as optional.

Net profit.

The buoyancy of these estimates of income is self-evident, and taking the probable gross income at only 5 lakhs per annum, and the annual disbursement 1 lakh, we have a net profit divisible of 4 lakhs or £40,000, which will give a clear income of 10 per cent. on £400,000, the estimate before referred to.

Collection of customs.

Harbour Master's Department.

Of the expense of the customs collection, the savings to be made *pro râta* on the quantity of goods, the cost of the Harbour Master's establishment, and the profit on outlay thereby incurred, it is beyond our power to say much. The expenses attending the collection of customs are doubtless easily and usually estimated in a percentage on the goods chargeable. The principle of maintaining the Harbour Department on a remunerative plan with sufficient surplus to maintain a gradual and healthy improvement without absolute profit, is also generally assented to and assumed to be acted on in this case.

Summary.

The maintenance of the docks, their gradual development and future hopeful state, is here proposed to be placed on the safe basis of capital remuneration, benefit to shipowners, merchants, manufacturers, and tradesmen, and on the general increase of revenue and the developed capabilities of a fertile empire.

Proposals for the construction of Docks at Calcutta.

From J. F. Leith, Esq., Chairman, Eastern Bengal Railway Company; D. Mackinlay, Esq.; C. Henfrey, Esq., for Messrs. Brassey, Wythes, and Co.; Rear-Admiral W. H. Hall; and W. B. Lewis, Esq., Secretary; to His Excellency the Governor General of India in Council,—dated 18th May 1864.

We have the honour to address you on a subject of great importance to the commercial prosperity of India, in which we and those whom we represent are much interested.

2. On the 6th February last, a somewhat similar communication (a copy of which is enclosed), supported by memorials from the leading merchants and ship owners of London, Glasgow, and Liverpool, was forwarded to the Right Honourable the Secretary of State for India, who, on the 9th of the same month, received by appointment a deputation from our body, whom he informed (after discussing the objects of the Company with much interest) that he could not officially take the initiative in such a matter, which must be referred to the Government of India at Calcutta.

3. Accordingly we now beg to lay before Your Excellency the proposals then made, accompanied by the following remarks.

4. Various plans have been discussed for affording those additional facilities at Calcutta which are urgently required for the accommodation of its large and increasing maritime trade; the most favoured of all has been the construction of docks. But no steps have been taken towards providing these; not, it would appear, because of the objections raised to them—for there has been the same inaction with respect to other schemes to which the like objections could not apply—but chiefly, it is believed, because no well-considered plan made by parties likely to carry out their proposals has been submitted to the Government of India or the Calcutta public.

5. It is the aim of the parties hereto to supply this desideratum, and they approach the Government with proposals which they submit are sufficiently defined to admit of their merits being fully considered, and to form a basis for a concession.

6. A careful consideration of the nature of the port and the character of its commerce has led to the belief that any scheme that will adequately accommodate the trade must embrace the supply of dock, and also river wharfage, and that these should be under the same management to ensure both being worked to the greatest advantage and prevent baneful competition, as well as to promote economy in the first cost.

7. The works proposed are shown on the plans sent herewith, and are described more in detail in the Engineer's report appended hereto. They consist (Plan No. 1) of a dock of about 50 acres, and a river quay abreast of the town of about 1,400 yards, or (Plan No. 2) of a dock of about 30 acres and river quays at the entrance to the dock and alongside the town, amounting to 2,000 yards' run altogether.

8. The estimate for these works is £1,000,000, exclusive of land, which, it is assumed, will be provided by the Government in the manner usual for public works in India.

9. Responsible contractors (Messrs. Brassey, Wythes, and Co.) are prepared to carry out the designs, and arrangements have been entered into with capitalists by which the sum required is guaranteed to be raised if the Government are willing to grant a concession on what are conceived to be equitable terms.

10. While desiring to state the leading features of their propositions as definitely as possible, the parties hereto wish it to be understood that they are prepared to consider any modifications that the Government might suggest, and to leave all details to be settled in conference with the local authorities.

11. It is submitted that any works now undertaken should be on a scale sufficiently large to meet the exigencies of the present and future probable trade, should be capable of extension hereafter, and should be so laid out as not to hinder, but rather facilitate, further improvements in the port. These points have been borne in mind in designing the works proposed.

12. It has been urged against docks at Calcutta that, owing to the alluvial character of the soil, their construction would be extremely difficult; that so large a mass of stagnant water, into which impurities must necessarily be cast, would become putrid in a tropical climate; that the vessels and warehouses being crowded together would become unhealthy, and that the water of the Hooghly, owing to the amount of soil held in suspension, is not fitted for dock purposes.

13. Modern science and engineering experience are capable of surmounting the difficulties of construction, and the opinion of the engineers, coupled with that of the contractors, is sufficient evidence of this.

14. The dock is purposely arranged with entrances at each end, so as to admit of the water being changed as often as may be requisite, and thus the dock kept free from impurity, whilst its size and the arrangement of the warehouses will be such as to admit of ample ventilation, and it is believed that the spot may be made perfectly healthy.

15. The mud deposited may be dealt with by scouring, dredging, or other means in ordinary use.

16. The objections to a dock being removed, the next question that presents itself is—where should it be placed?

17. The following sites have been suggested, *viz.*, at Chitpore; on the river banks in front of the Mint; near the East Indian Railway Terminus at Howrah; or at Kidderpore.

18. Chitpore is situated above the town, and would involve all the shipping passing the most crowded part of the river to reach it. This would be a serious objection alone, but it entails as a consequence serious impediments to the prospect of ever erecting a bridge between Calcutta and Howrah. The approach roads also are inadequate to meet the traffic, and great difficulties stand in the way of opening a wider road or forming a tramway. Difficulty also would be found in dealing with the important roads leading towards Barrackpore.

19. The site before the Mint is already occupied by the native craft and inland river boats, and is close to the quarters of the native traders, whose interests would have to be purchased at considerable cost, and whose displacement would interfere with their religious prejudices. The space also is too limited, and this site, as well as that at Chitpore, would involve vessels passing all the craft in the river before entering the dock, and interfere with the bridging of the Hooghly.

20. Many reasons may be urged for a dock at Howrah. The great importance of the traffic brought by the East Indian Railway seems to point to a bridge at some time being constructed to connect its terminus with Calcutta, accompanied probably by dock accommodation on the western side of the river; it is therefore submitted that no steps should be taken that would interfere with the realization of these prospects. But the whole present course of trade, the situation of the merchants, warehouses, and the position of the termini of the Eastern Bengal and South-Eastern Railways and of the Eastern Canals seem to point conclusively to the eastern or Calcutta side of the river as being that upon which docks should first be made.

21. On the Calcutta side the Kidderpore site offers many and commanding advantages. It has been recommended by committees who have well considered the subject; there is a bend in the river between the anchorage opposite Calcutta and Garden Reach which will maintain deep water at the dock entrances. There is sufficient space not occupied by valuable property to admit of a capacious dock being now made and largely extended if needful hereafter; it admits of the entrances being most conveniently placed, and it is near Tolly's Nullah. Access may be easily obtained to it by a railway from the existing eastern lines, and a tramway might be carried to it from the quays opposite the Custom House alongside the river, thus affording communication with the centre of the town. This tramway may be carried past Fort William without interfering with it.

22. These are amongst the considerations that have led to the selection of the site at Kidderpore, shown on the plan.

23. With reference to the advantages of the proposed river embankment and continuous quay frontage, little need be said. Although the current in the river will render the quay a less desirable place for vessels to lie at than the dock, there must ever be a large amount of trade carried on by lighters and river boats, and the facilities offered by this wharf for landing goods close to the principal warehouses will be very great, besides the general advantages of reclaiming the large extent of mud bank on the river shore.

24. It will be urged by some that the state of the River Hooghly below Calcutta is becoming so unsatisfactory that a large outlay in docks and wharves at the town could not be justified. But it must be evident that the trade is altogether too large and important to be abandoned or shifted, and that, should the river hereafter become difficult for the passage of large vessels, means would be adopted either by the construction of a canal to the Mutlah, or works of improvement in the Hooghly, to maintain a communication with the sea. The proposed works would then be equally available, and are designed with a view to meet such a contingency.

25. We beg leave further to submit the following suggestion, *viz*,—That the Company should be authorised to levy tolls in such manner and subject to such control and at such rates as may be agreed upon with the Government on all vessels entering the port, and on goods landed; such rates not to be disturbed until the Company is able to declare a dividend of, say, 10 per cent. Then the Government might have power to revise them, but not so as to reduce the dividend below this amount.

26. The tolls it would be requisite to charge would be considerably less than the expenses now incurred by merchants in landing their goods.

27. The immediate object of this application is to solicit from the Government an expression of opinion, first, whether the project meets with their approval; secondly, whether they would concede the construction of such works to the Company; and thirdly, whether they

would sanction the levying of tolls in the manner and under the restrictions above mentioned, so as to secure to the Company a minimum income.

28. In the event of the Government favourably receiving these proposals, and agreeing to the principle of a concession, we would venture very respectfully to suggest that an early intimation of their views will greatly expedite future proceedings, as, under such circumstances, the organization of the Company would be immediately completed, and a thoroughly competent and skilled person would be sent out in the autumn to meet the local authorities, so as, in concert with them, to mature the plans, and settle the terms of the concession.

Report of the Committee appointed to consider and report on the Junction of the East Indian Railway with the Eastern Bengal Railway by a Bridge over the Hooghly; on the formation of Wet Docks; and on other matters connected with the convenience of the Trade and Shipping of Calcutta.

The first question that calls for consideration is—How to deal with the terminal station of the East Indian Railway; shall it remain at Howrah; or shall the railway be brought across the Hooghly by a bridge, and a terminus be formed in Calcutta?

2. The Committee has no difficulty in adopting the conclusion that the East Indian Railway should have its terminus both for passengers and goods brought to Calcutta, and that a bridge over the Hooghly should be constructed. This arrangement seems desirable both in the interest of the Railway Company and of the public. The inconvenience of the present terminus at Howrah, more especially for goods, is very great. The construction of a railway bridge to give direct communication between the East Indian Railway and the Eastern Bengal and Calcutta and South-Eastern Railways is of great importance.

3. The railway bridge will be best placed at the nearest point to Calcutta at which such a structure would be safe from risk of ships breaking loose from their moorings in the Hooghly. This, from the evidence given, will determine the site for the bridge, about 2 miles above Cossipore Foundry.

4. By bringing the bridge as near to Calcutta as possible, the convenience of the large suburban towns on the right bank of the Hooghly will be served, while the main interests involved will be equally well met. There seems no reason to think that any advantages in the way of engineering facilities of construction or reduction of cost would be got by placing the bridge higher up the Hooghly, that would compensate for the diminished convenience to the public of such an arrangement.

5. There appears no real necessity for the provision of a direct communication by bridge between Howrah and Calcutta. The present importance of Howrah essentially depends on its being the site of the East Indian Railway terminal station. If this be brought over to the Calcutta side of the river, the wants of Howrah will be quite easily met by a good steam ferry.

6. The construction of a railway bridge below Cossipore would not only be objectionable on the score of danger from ships in storms, &c., but because it would seriously limit the available space in the port, which is already inconveniently small. Further, the erection of a bridge below Cossipore would finally bar the formation of wet docks to the north of Calcutta.

7. It does not seem desirable to form a carriage way in connection with the railway bridge on account of the large extra expense involved. The wheeled traffic across the Hooghly above Cossipore would certainly be very small. A path for foot passengers might be given.

8. The Committee considers that the most convenient place for a suburban passenger terminus for the East Indian Railway will be Sealdah. The ground occupied by the existing terminus of the Eastern Bengal Railway Company is amply sufficient in extent for the passenger stations of both Companies, and the Committee advises that, if possible, this site should be appropriated for the passenger traffic of these two railways; the present Eastern Bengal Station being transferred to the East Indian Railway Company, and a new passenger station being formed for the Eastern Bengal Company, immediately to the east of it on the ground now reserved for the goods station of the latter Company.

9. If this plan be adopted, the East Indian Railway line would run from the Hooghly Bridge to the Eastern Bengal line, which it would join near the Dum-Dum Station. From this point the present Eastern Bengal line would be transferred to the East Indian Railway, a new line being constructed for the Eastern Bengal Company to the east of the present railway bank. The new line would cross the canal close to the present Eastern Bengal Bridge, and run up to the new Eastern Bengal Station over the present goods yard of that Company.

10. Under this arrangement, the whole of the works would have to be carried out at the cost of the East Indian Railway Company.

11. The Committee thinks that every effort should be made to effect this arrangement, and that no other would be thoroughly satisfactory. It would, so far as the Committee can judge, be as convenient to the Eastern Bengal Railway Company as to the East Indian; but as it is possible that the former Company may object to it, and be able to satisfy the Government, on grounds which do not present themselves to the Committee, that it should not be adopted, it is necessary to consider the plans put before the Committee by Mr. Power, the Chief Engineer of the East Indian Railway.

12. Two alternatives are suggested,—either to form the terminus of the East Indian Railway in the angle between the Eastern Bengal line and the branch of the canal next to the Sealdah Station, or in a closely adjoining position, between the canal and the Circular Road.

13. In the former case, it might probably be expedient to bring the East Indian Railway line along the Eastern Bengal bank, as before suggested.

14. In the latter, it would be necessary to form a new line running nearly parallel to the Eastern Bengal line, as far as a point about two miles north of the Chitpore branch of the canal, whence it would turn down to the bridge over the Hooghly. This arrangement would require a separate branch to give communication with the Eastern Bengal line.

15. So far as the position of the East Indian Railway terminus is concerned, the second site would have the advantage. But it is almost certain that the cost of the land required would be so greatly in excess of what would be necessary in the other case, that the Government could not be expected to agree to placing the terminus between the Circular Road and the canal.

16. In both of the plans last named, if the passenger and goods stations were combined, the terminus of the East Indian Railway would necessarily be formed on the ground surface. If the goods station were elsewhere, the passenger station might be at a high level like the existing Eastern Bengal Station at Sealdah.

17. This remark is made having reference to the possible construction of a metropolitan or suburban line, the former to connect the main passenger stations with the centre of Calcutta near Tank (Dalhousie) Square, the latter to give railway communication to the suburbs from Chitpore to Kidderpore or Garden Reach. Such lines must certainly be formed at a high level, and there would be some inconvenience if the main stations were not nearly on the same level.

18. The Committee confines itself to stating its opinion that the construction of such lines as these last named would be undoubtedly a great convenience to the public. The cost of construction, including the price of land, would be great, and the traffic must be very large to ensure a profitable return. There is every reason to think that a very large passenger traffic would spring up on such lines, and the Committee may hope that capitalists will come forward to undertake them; but the Committee can see no sufficient reason for advising that assistance should be given by the Government to such railways, beyond what would be naturally granted under Act XXII of 1863.

19. On the whole, the Committee advises that the East Indian Railway passenger station should, if practicable, be on a high level, and in such a position that its formation would not be likely to interfere with a future suburban railway, and that easy communication with a suburban or metropolitan line might be practicable. These conditions will be far best met by the arrangement first recommended by the Committee, *viz.*, placing the East Indian Railway Station on the present Eastern Bengal Railway Station site. But if either of the other two plans referred to be forced on the Company, the above points should not be overlooked.

20. As to the position of the East Indian Railway Calcutta goods station, the Committee believes that there is no necessary connection between the goods and passenger traffic of a railway, and, indeed, that there is increased convenience in entirely separating the principal goods and passenger stations when the traffic is heavy. This remark, and the observations in the four following paragraphs, apply as strongly to the Eastern Bengal goods station as to

that of the East Indian line; and it may be added that, if it be found practicable, there would be many important advantages in having the main goods stations of these two railways in contiguous positions.

21. As regards the convenience of the trade of Calcutta, there seems little to choose between any site along the canals and Circular Road, from Chitpore to Sealdah. The main business in warehousing, &c., is carried on in the part of the city bordering on the Hooghly between the Custom House and Chitpore, and all points on the line named would be nearly equidistant from the centre of this class of business.

22. It is a fact sufficiently attested that the trade of Calcutta, as now conducted, requires that the mass of the goods for export (which form the most important part of the goods dealt with by the Railway Companies) shall be re-packed in Calcutta. This involves their delivery by cart at the warehouses of dealers. Probably the formation of wet docks, with warehouses attached, might hereafter, in some measure, change the habits of the trade, but meanwhile the requirements of the existing state of things must be met. Hence a large ordinary goods station must be formed, suitable for the present condition of business, quite irrespective of the question of docks.

23. At the same time there can be little doubt that it would be a great advantage if the railway goods stations were near wet docks, should they be constructed.

24. As will be more fully explained hereafter, the Committee considers that there are special facilities for the formation of a wet dock near Chitpore, and some probability of such a dock being undertaken. Under these circumstances, the most suitable site for a railway goods station will, they think, be at some point to the north of the canal at Chitpore near the junction of the Barrackpore and Dum-Dum Roads. So far as the town trade is concerned, the site is unexceptionable, and if the dock be executed, the arrangement will be very satisfactory to all interests.

25. Having in view, however, the possible failure of the expectations of the Committee as to the construction of wet docks, and coming to a satisfactory arrangement with the Eastern Bengal Company as to the Sealdah passenger station, it is necessary to refer to the plans that would be followed if the East Indian Railway had a joint goods and passenger station in either of the two positions indicated by Mr. Power.

26. The site between the canal and Circular Road would certainly be the most convenient of access, and, so far, the best of the two. Also, this site has the advantage of admitting railway communication for the interchange of goods with the Calcutta and South-Eastern line on the level of the ground. The connecting line would pass under the Eastern Bengal Railway at the first canal bridge. All the roads crossed by the railways would be provided with bridges over the line; if sufficiently easy slopes were given, this would not be a serious objection.

27. If the site between the canal and the Eastern Bengal Railway were adopted, the communication with the Calcutta and South-Eastern line could only be made on the level of the ground by stopping the traffic on the canal. As it is understood to be intended to regard this branch of the canal only as a dock for the Calcutta trade, and to open a new through line into the Hooghly, perhaps such a line of railway would not be thought a serious objection. Otherwise a swing bridge might be constructed to take the rails over the canal, which would be as little objectionable as such works can be, inasmuch as the only traffic over it would be goods passing between the Mutlah and the East Indian Railway Station; or the Calcutta and South-Eastern goods might be taken by a high-level line to the *east* of the Eastern Bengal Station to join the latter railway at a convenient point beyond the first canal bridge. The present line of communication runs through the Eastern Bengal goods station, and is otherwise not suitable for working a traffic of any magnitude.

28. As before said, when treating of the East Indian Railway passenger station, the choice between the two localities, east or west of the canal, must mainly be settled on a consideration of the additional cost of the latter. The same remark applies, of course, to the goods stations. The impression of the Committee is that the site next to the Circular Road is barred by the expense of the land.

29. It is not necessary for the Committee to make any final recommendation as to the mode of joining the Calcutta and South-Eastern Railway with the East Indian Railway. Of the different plans that may be adopted, that must be selected which the Government and the Company shall think on the whole most convenient when the arrangements to be adopted for the East Indian Railway line shall be finally settled.

30. With respect to the Eastern Bengal goods, the Committee is disposed to think that, if a wet dock be formed near Cossipore, the goods station of this railway should be placed

near the docks and East Indian Railway goods station. The existing arrangement, by which the goods station is on the high level close to the passenger station, is certainly objectionable, as leading to very large expense in making extensions. It is otherwise inconvenient to have the access to a passenger station obstructed by the carts that must fill the approaches to a large goods station.

31. The Committee is not prepared to make any definite proposal as to the position of the Eastern Bengal goods station, in the event of the present Eastern Bengal Station being entirely appropriated to the passenger traffic of the two larger railways, and of the Chitpore site being rejected. It may be suggested, however, that this goods station might be formed on the level of the country, either between the present Sealdah Station and the Balliaghatta Road west of the canal; or just beyond the canal to the east of the Railway; or alongside of the East Indian Railway goods station between the Railway and the Nurkaldanga Road. On the first plan, the access would be by a bridge across the canal stopping the boat traffic, or by a swing bridge (as before explained in the case of the Calcutta and South-Eastern junction line), both at a low level. On the second plan, no such canal bridge would be needed. On the third plan, access must be given to the goods station by a line looping round and passing under the main railway embankment. It seems sufficient to leave the determination of this matter to the Government in communication with the Railway Companies.

32. The arrangement of the Calcutta and South-Eastern Railway terminus is in no way affected by the questions specially referred for the opinion of the Committee, and it seems needless to discuss this subject at present.

33. The general scope of the conclusions of the Committee therefore is, that the public convenience will be best met by massing the passenger traffic of the East Indian and Eastern Bengal Railways at a high level at Sealdah, whence metropolitan or suburban passenger lines can hereafter be extended; the goods traffic being brought together to a central position on the bank of the Circular Canal near Chitpore. If these arrangements are, as the Committee believes, the best for the public, they must also, as a matter of necessity, be the best for the Railway Companies. But as they involve considerable changes of existing plans, and as the two Companies must be got to consent before they can be adopted, the Committee has thought it expedient to refer to other arrangements, which, no doubt, offer possible, though far less satisfactory, solutions of the question under discussion. It might be added that it would seem well for the Calcutta and South-Eastern Company to consider whether they also should not adapt their passenger and goods stations to the places now recommended, for the two other main lines having their terminus in Calcutta.

34. The only other point calling for notice, in connection with the railway arrangements, is the method to be adopted in obtaining the earth for the formation of the bank on the raised portion of the line between the Hooghly Bridge and the Eastern Bengal line, or the canals, as the case may be. Mr. Power, the Chief Engineer of the East Indian Railway, has proposed that, instead of taking up a strip of land sufficiently wide to provide the earth from shallow side-cuttings, a single deep excavation shall be formed in a convenient position, from which all the earth shall be taken to the bank by steam power. This arrangement will certainly be most economical to the Government, as it will save the purchase of a large area of land. It will probably not be more costly to the Company, and will be advantageous as avoiding the formation of the unsightly and objectionable excavations along the foot of the embankment which would otherwise be necessary.

35. But another important contingent advantage would arise from the adoption of this system of forming the bank, namely, that it opens the way for giving aid to the formation of a wet dock, in the locality which the Committee considers to be well adapted for a first experiment in this class of works without causing any burden on the State or the public. Obviously so large an excavation as will be necessary to form the banks for the new line of the East Indian Railway, Mr. Power estimating it at 30 acres, will at once be available as the nucleus of a wet dock, and the site of the excavation which will be the property of the Government might, so far as the pecuniary interests of the Government are concerned, be handed over free of cost for adaptation for a dock basin.

36. The temporary lines of a road which will, under any circumstances, be necessary for conveying the earth to the main railway bank, may quite conveniently be laid out so as to serve for the permanent approach to the docks and the goods station.

37. On the whole, the economy of combining the construction of the new line of main railway with the excavation of a dock basin, and the formation of a railway goods station

near it, will be very large, and the grant of the excavated site may be roughly estimated as equivalent to a contribution of at least £40,000 or £50,000 towards the expense of the docks.

38. The Committee observes that, by a suitable arrangement of the works, these possible advantages will be, in a great measure, secured for the future, whether the wet docks be actually constructed at once or not; and they strongly recommended that these considerations shall be carefully attended to in the final decision adopted by the Government. The subject will be further discussed in a later part of this report when the Committee enters more particularly on the subject of wet docks.

39. The entire cost of the railway works that the Committee has suggested will probably not exceed £800,000, and the importance of the objects to be attained by them seems fully to justify such an expenditure. This additional outlay does not seem of undue magnitude reckoned in relation to the capital of the East Indian Railway, and bearing in mind the very great importance of obtaining a satisfactory metropolitan terminal station.

40. These are all the remarks which the Committee desires to make on the subject of the connection of the railways at Calcutta, and the remainder of this report will relate to the question of the formation of wet docks, and other matters connected with the convenience of the trade and shipping of Calcutta.

41. The general enquiries which the Committee has made as to the requirements of the trade of Calcutta has led it to the conclusion that the first thing calling for attention is the improvement of the means of landing imports and passing them through the Custom House; and the Committee has accordingly already made the following recommendations to the Government.

42. It has been recommended that immediate measures should be taken to provide jetties, in connection with suitable landing sheds and warehouses, on that portion of the Strand bank that lies between the Bankshall and Armenian Ghats.

43. That such jetties, sheds, and warehouses should be placed under proper Custom House control so as to admit of imports being landed, examined, and passed, on the extended frontage referred to, in the manner in which they are now dealt with at the Custom House. If necessary, an enclosure surrounded by a railing might be formed to embrace the whole of such works, due public access being, of course, reserved from the river to the shore at such points as may be deemed expedient.

44. That suitable arrangements should, at the same time, be made to admit of the shipping of export goods from such jetties, sheds, &c., to such extent and in such manner as may be requisite for the convenience of the trade of the port.

45. These recommendations are made irrespective of any decision which may ultimately be come to on the subject of wet docks; the Committee being satisfied that, even should wet docks be constructed, the facilities suggested would still be urgently required for vessels which may not find accommodation in the docks, or which may find it more convenient to discharge from the river.

46. That on the completion of the suggested works, any needful increase should be made to the examining and appraising establishments of the Custom House, to allow of the speedy clearance of goods.

47. That the construction and management of such works would be best undertaken by a Public Trust, such as has already been proposed for carrying out works for the improvement of the port of Calcutta, and that the shorter Bill now before the Legislative Council of the Lieutenant-Governor of Bengal seems generally to provide well for all the matters to be dealt with in constituting such a Trust.

48. The Committee considers a Public Trust better fitted for the carrying out of such works and duties as have been spoken of than a private company, for the following reasons :—

1st.—That it is inexpedient to create private rights and interests on the banks of the River Hooghly, which is, and always must be, the public highway for the sea-borne trade of Calcutta.

2nd.—That all preliminary difficulties as to the rates to be charged for landing, wharfage, warehousing, &c., which would arise in negotiating with a private company, will be avoided if the works be carried out by a Trust.

3rd.—That the delay in forming a company will also be thus avoided, as well as all questions as to the terms on which a company should receive a lease of the Strand bank.

4th.—That the Trust, acting in behalf of the community, will not desire to make any further profit on the undertaking than will pay the interest on the money invested, and the charges for maintenance and management.

49. The Committee also thinks that, so soon as the needful accommodation of the character spoken of has been provided, it should be made lawful for the master or owner of any ship, three working days after the ship has been entered inwards at the Custom House, to land at any jetty, wharf, &c., duly approved by the Bengal Government in that behalf without consulting the consignees, all goods which shall not have been claimed by the consignees; provided that the consignees shall be bound to use all due diligence in removing goods after they shall be claimed, and if such due diligence be not used, it shall be lawful for the ship-master or owner to land such goods in the manner aforesaid, notwithstanding such claim. The landing of goods in this way should be conducted under suitable regulations to be approved by the Lieutenant-Governor of Bengal, and framed with a view to the protection of the legitimate interests of the consignees as to damage done before landing. Also such landing should not be allowed at variance with charter-parties or bills of lading which contain agreements for allowing a certain number of days for the discharge of cargo. The Port Trust would become responsible for goods when landed, holding a lien on the goods to recover all lawful charges thereon in the manner in which the officer in charge of the Custom House is now responsible, under Section LII of the Consolidated Customs Act (VI of 1863). For this purpose, a modification of the clause of the Customs Act, under which goods cannot be landed till 15 days after the ship has been entered inwards at the Custom House, will be necessary, for which authority will be required from the Council of the Governor General.

50. The Committee has submitted a draft Bill for giving effect to that part of the above suggestions that refers to the modification of the Customs Act, and has forwarded to the Government of Bengal the amendments that the Committee recommends in the Bill for the formation of the Calcutta Port Trust, now before the Bengal Legislative Council.

51. The above measures seem to the Committee those most likely to give immediate relief. The construction of jetties and landing sheds should be a work of comparatively small expense, and should be susceptible of being carried out by degrees, some portion of the works being brought into use at a very early period. If proper activity be shown, the Committee sees no reason why arrangements of this character should not be in actual operation before the end of the present year.

52. Before quitting this part of the subject, it may be useful to refer more particularly to some matters connected with the formation of a Port Trust for Calcutta, which have been under the consideration of the Committee.

53. The Committee has adopted the conclusion, already approved by the Government of Bengal and the Government of India, that the proposed works be best carried out and managed under a public Trust. The reasons for prefering a Trust to a private company have already been explained; and the Committee, indeed, thinks that no other practical system of management for the purposes in view can be found at the present time. The only possible alternative would be to carry on the works under a special Government office or department. The Committee looks on such a plan as out of the question. In the first place, the Government will not supply, from the ordinary revenues, the funds for objects such as those contemplated, which are essentially local in their character. The needful money must be raised locally, and some local machinery must be created for this purpose. If the funds are raised under local responsibility, the management must be local also. The creation of a local fund involves the idea of a trust in one form or other. Of course the Local Government might be the trustee, if such a plan were deemed the best, and all the powers might be placed in the hands of the Lieutenant-Governor of Bengal. In the opinion of the Committee, this would not be desirable, and the formation of a sufficiently strong executive administration might, it is believed, be secured, without losing the advantages that would certainly be derived from the participation of a body of merchants in the business.

54. In illustration of the practical inaptitude of the Government to advance such funds as those contemplated by the Committee, it seems sufficient to refer to the past history of these

questions, and to the fact that, after half a century of discussion, nothing whatever has been done. The history of the Mutlah port teaches the same moral. The sums available from the general revenues for purposes of public improvement are so small, and the demands of all sorts so large, that, in practice, nothing can be given for objects of which it may legitimately be said that they should be provided by local effort and local funds.

55. A Trust to be effective must obviously be so constituted as to have a responsible head with ample executive powers, and such an officer must be salaried. Too large a body is to be deprecated, and the Committee considers nine sufficient. It will be important to ensure a full attendance at the meetings of the Trustees, and it may be found expedient to give each Trustee a small fee for attendance. It seems objectionable, at the present time, to tie down the Trustees to any rigid form of procedure in the performance of duties and distribution of responsibilities; it will be better to allow such matters to be disposed of in the way which experience may show to be most suitable. If necessary, the Trust Act could be amended a few years hence, and the system of working the Trust defined more exactly after actual trial; but the position of such a Trust is not comparable to that of a Corporation to manage the municipal government of a city, and there is no necessity for attempting to give extreme precision to the rules for conducting its business. So, also, the functions of the Trust may best be made as simple and as few as possible at the outset. If experience shall show that such a body really performs well the business now proposed to be entrusted to it, the extension of its duties and powers can easily be made hereafter. For the present, the construction of the jetties, &c., is the important thing, and the undivided attention of the Trust should be directed to the speedy accomplishment of this.

56. The Committee would look forward to the Trust eventually relieving the Custom House authorities of all the duties now performed by the latter, in connection with the custody of goods passing through the Custom House. As the arrangements of the Trustees are perfected, the warehouses on the existing Custom House premises might be transferred to the Trustees, and improved at their charge, so as to form a system of bonded warehouses in connection with the jetties on the river bank. The contemplated compulsory landing of goods three days after the entry of the ships, will make it necessary to provide the means of warehousing goods which are not promptly removed by the consignees from the landing sheds, or the latter will become choked. Under suitable rules, this warehousing will be quite easy, if warehouse space be provided, and connection given between the landing sheds and warehouses by means of rails and trucks. The present Custom House premises will give ample space for capacious warehouses, and the construction of such buildings there will be quite unobjectionable.

57. The Committee has no difficulty in adopting the conclusion that the cheapest and simplest means of giving increased facilities for the landing of goods from the river will be the formation of jetties with iron screw-piles. It is extremely doubtful whether a permanent continuous wharf-wall could be constructed unless at a cost that would render such a work impracticable. The Committee, however, thinks that it would be going beyond the line of its duty if it entered on any special discussion as to the exact works to be erected. Such matters must plainly be left to the decision of the persons responsible for carrying out the works, and it would probably rather tend to create difficulties than to remove them if the Committee attempted to lay out a detailed scheme for the operations of the Port Trust.

58. The Committee has further formed the opinion that wet docks, if constructed at Calcutta, are as likely to be useful, and to pay a sufficient dividend on the capital invested on them, as docks in any other port; and though there is not any general conviction that dock works can at the present time be regarded as absolutely essential, yet it seems to be admitted, almost without exception, that they would greatly add to the convenience of the port, if constructed.

59. The solution of the question whether docks are, or are not, *essential* for the convenience of the port, mainly depends on the number of ships remaining in it at one time. The effect of the construction of jetties, as proposed by the Committee, and of the development of Port Canning on the Mutlah, must be awaited before any decisive reply can be given. The increase of the trade during the last few years leads, however, to the conclusion that all possible aids will very soon be required, and that although there seems no reason for trying to force the development of any one means of relief, or to stimulate the construction of wet docks in any exceptional way, yet the Government will do well to give all reasonable facilities, short of direct pecuniary aid, or guarantee of interest, to every well-considered and suitable scheme for improvement.

60. The Committee, therefore, is of opinion that the proposals of the "Calcutta Dock and Wharves Company," represented by Mr. Prestage, for constructing docks at Kidderpore, which involve the grant of the necessary land, at a cost to the State of £250,000 or £300,000, and of a 5 per cent. guarantee on the outlay of the Company, estimated at one million, to be obtained by a general rate on all shipping entering the port of Calcutta, should be rejected by the Government.

61. It remains to be considered whether there are any sufficient general objection to the construction of wet docks at all, and what localities offer the greatest facilities for them.

62. While the Committee recognises that there may possibly be some special risks and inconveniences in the construction and working of wet docks at Calcutta, partly due to the climate, partly to the character of the river and soil, partly to the special nature of the trade, on the whole none of these considerations seem to be of a nature to throw reasonable doubt on the general beneficial nature of such works if reasonable precautions be taken in dealing with them.

63. The first question that calls for notice is that of salubrity. It has been stated that even in England wet docks are at times extremely offensive, and that, in a tropical climate, the risk of this description is far increased. But apart from the circumstance that the above fact does not give positive proof of wet docks being causes of sickness, there seems no sufficient reason why, if proper precautions are taken to prevent filth being thrown into the basins, and to ensure a daily change of a sufficient quantity of the water, bad effects of this sort may not, at all events, be so far prevented as not to leave reasonable ground for refusing to accept the real advantages of docks, only to avoid risk to the public health, which is, in some measure, speculative. As to the mere surface of stagnant water, the aggregate area already existing in and around Calcutta in the shape of small tanks is so extremely large, that the formation of wet docks will hardly affect the total quantity. It is, of course, no argument for the addition of fresh nuisances that others far worse already exist, but there is every reason to believe that, under proper police supervision, a wet dock would be far more sweet and wholesome than a large number of the existing tanks in the suburbs of Calcutta.

64. At the same time, to guard against possible risk in a first undertaking of this sort, it might be prudent for the present to prevent the construction of docks close to the south of the town, as it is from that quarter that the wind blows almost constantly during the hot months of the year, when the risk of the development of offensive effluvia may be considered the greatest. Hence the formation of a wet dock at Kidderpore might reasonably be objected to on this ground,—at all events until some actual experience has been got of the effects of such works on the public convenience or health.

65. The next objection that may be referred to is the difficulty of providing for the crews of ships brought into the wet docks. As it will unquestionably be necessary to remove the crews from the ships, it will almost certainly be necessary to construct dwellings for them. This should, therefore, be done as part of any scheme for wet docks, and it will be an advantage to the seamen of a very high order, and one which might fairly be held far to outweigh general objections on sanitary grounds such as have just been referred to. The Committee is inclined to think that the Government should use every means in its power to secure attention to the provision of suitable lodgings for European seamen belonging to ships entering the docks, should any project for such works take a practical shape; and if this be accomplished, the results on the health and comfort of the population of European seamen visiting the port cannot fail to be very satisfactory. The Committee believes that there is no class of the European community in India that so much needs consideration at the present time as these seamen, and desires to commend them specially to the care of the Government and of any company coming forward to construct wet docks.

66. Great care, no doubt, must be taken to prevent accidents from fire, but, with proper precautions, there seems no reason why this risk should be such as to be regarded as a practical objection to wet docks.

67. As to the deposit of silt, it is a difficulty that must be faced. That the mud deposited can be removed by dredging there is no doubt; the operation will, of course, be an element of cost unfavourable to the profits of the docks, but otherwise it seems to call for no special comment.

68. In considering the localities available for wet docks and their relative advantages and disadvantages, the first and most obvious fact is, that the cost of land is high in propor-

tion to its proximity to the centre of business, and that the greater the convenience of the site, the greater is likely to be the difficulty of obtaining it for docks. In this sense, the two suburban sites at Chitpore and Kidderpore are at a great disadvantage when compared with Howrah, Garden Reach, or Akra.

69. The cost of execution of the works will, in a considerable degree, depend on the depth to which the excavation has to be carried. This not only affects the quantities of soil to be moved, but the difficulty of disposing of it after it has been taken up. At Chitpore and Kidderpore the depth will probably be ten or twelve feet greater than at Howrah or Akra, the level of the surface being far lower in the two latter localities.

70. The necessity for providing ready means of access to the railways is another important consideration. In this respect the Howrah and Chitpore sites have great advantages. The Kidderpore site would involve four miles of railway through the suburbs of Calcutta, and docks at Akra would require a still greater length of line. Docks at Howrah would be almost in contact with the East Indian Railway Company's Howrah Station, and if the Calcutta goods terminus of this railway be made, as has been proposed, near Chitpore, nearly the same remarks will apply to the Chitpore site for docks.

71. A most important consideration in the practical utility and convenience of docks when constructed, is their accessibility to the merchants whose business is transacted in them. In this point of view, the Chitpore site and Kidderpore are much on a par. The latter, however, is less advantageous; and to the uncommercial public this site would incline to be directly a cause of inconvenience, as leading to the creation of a heavy goods traffic across the part of the town occupied by the residences and public drives of the European inhabitants. Such inconveniences might be guarded against by strict police regulations, but these again would seriously affect the commercial accessibility of the docks.

72. The site at Howrah, being on the opposite side of the Hooghly to the places of business of the Calcutta merchants, is open to considerable objection, which will, it is true, be in part removed by the establishment of railway communication across the Hooghly, and by the improvement of the steam ferry, but which will still, in the opinion of many persons, be very great.

73. The distance of Akra is, of course, still more objectionable, and unless complete railway communication were established and frequent trains run to docks at that locality, they could not be regarded as satisfactorily placed.

74. The accessibility to the river of the various sites that have been referred to is another point of importance. So far as the information before the Committee admits of its forming an opinion, satisfactory entrances to docks could without difficulty be secured at Garden Reach, at Kidderpore, Howrah, and Chitpore. The Akra site is doubtful.

75. Besides the land sites alluded to, the river bed itself affords possible localities for the formation of docks. It has been a common system in England to cut off shallow portions of river beds and to enclose them as dock basins. It is, of course, possible to follow a like course in the Hooghly. But though great advantages would arise from the saving in the cost of land, and of excavation, it is a question whether the expense of forming and maintaining the wall or embankment between the basin and the river bed might not outweigh those advantages, and, on the whole, lead to a greater total charge.

76. As to the available space for ships in the several localities named, and the means of enlarging wet docks hereafter, should they at first be constructed on a small scale in a tentative way, the Committee thinks it hardly necessary to say much. There seems no necessity for having all the docks in one place; and in general terms it may be safely affirmed that the space available is ample, if the money be forthcoming, and the disposition to construct these works exists.

77. One point more should be noticed, namely, the relative security of the several dock sites, having in view the risk of an enemy's ships entering the river in time of war. Plainly, the Chitpore site would have great advantage in this respect, as it could not be approached without passing Fort William. A reasonable degree of protection would, in the same way, be given to docks at Howrah, if not carried too far down towards the Botanical Garden. Akra, Garden Reach, and Kidderpore would be wholly, or almost wholly, without defence.

78. Having referred to this subject, the Committee may add that it seems worthy of the consideration of the Government what precautions, if any, should be taken for the

protection of the port of Calcutta in the event of a war breaking out with a maritime power. It will, in every respect, be better that the subject should be discussed deliberately when there is time to do so, and to take any preliminary steps that may be shown to be desirable. This Committee is obviously not a proper body to enter upon such a matter, but it may state its opinion that there is apparently nothing to prevent the captain of a hostile ship of war, if he were so disposed, seizing a pilot at the Sandheads and forcing him to take the ship up to Calcutta. Colonel Strachey has handed in a memorandum on this subject, which is recommended to the attention of the Government.

79. On the whole, the Committee, on a review of the facts that have come to its knowledge, is of opinion that the Chitpore site has greater advantages and is less open to objections than any of the others; and that, if capitalists are prepared to carry out wet docks in this locality, then the Government will do well to co-operate with them for the purpose. In saying this, the Committee desires that it shall be understood that a directly unfavourable opinion is not entertained by it of any of the other sites, though, for the reason before given, it thinks that the Kidderpore site should not, at present at least, be adopted. It does not, however, seem likely that wet docks will be undertaken at more than one place for some time to come, and as the expression of the opinion of the Committee as to the most favourable locality may assist in determining English capitalists in making a selection, and in actually entering on such an undertaking, this opinion has been given.

80. The conclusion that has thus been adopted by the Committee as to the superiority of the Chitpore site has been arrived at irrespective of the special facilities in the way of economical execution, to which allusion has been already made when discussing the railway arrangements that will be necessary in bringing the East Indian Railway across the Hooghly; and considering the great practical superiority that will thus be given to the formation of wet docks at Chitpore, the Committee is satisfied that this plan offers such advantages as are not likely to be elsewhere met with, and as will probably determine any company really intending to enter on such works, to select this site, and commence operations as soon as a decision shall be come to by Government and the East Indian Railway to construct the Hooghly Bridge, and bring the East Indian Railway into Calcutta.

81. The Committee has received from Mr. Power, the Chief Engineer of the East Indian Railway, a copy of a letter from Mr. G. Turnbull, the Engineer of a Company lately formed in London to carry out wet docks in Calcutta, under the name of the "Docks and Warehouses Company of Calcutta," which seems to give promise that the means may at once be forthcoming to carry out wet docks on a moderate scale of magnitude, should the Government receive favourably these proposals. From the prospectus of this Company, there is no appearance of any intention on their part of asking further aid from Government than will be necessary for obtaining possession of the requisite land, and for levying dock dues on ships making use of the Company's docks. Should this expectation of the Committee be realised, the Government will, no doubt, be prepared to co-operate with the Company, and to enter into negotiations for the transfer to them on favourable terms, or free of charge, the land that will be required under any circumstances to supply the earth to make up the embankments of the new East Indian Railway lines.

82. The Committee has before stated its opinion that the proposals of the Company represented by Mr. Prestage should not be agreed to; yet, considering that this Company was the first to come forward, and that the Company represented by Mr. Turnbull has not yet made any definite offers to the Government, the Committee is disposed to think that it will be the fairest course if the Government, in making any concessions of the nature above referred to, gives the two Companies the opportunity of combining, so that the advantages of the Chitpore site may be shared by them both, if they continue to be desirous of carrying out wet docks.

83. To admit of an early settlement of this question, it seems necessary that it should be gone into together by the Government, the East Indian Railway Company, and the Dock Company, and the Committee desires to recommend to the Government of India that the requisite measures should be taken to accomplish this. The Committee believes that the interests of the Government, of the Railway Company, and of the public, will be greatly advanced if a satisfactory agreement can be come to between the principal parties concerned in carrying out the general scheme of works that has now been suggested.

84. But the Committee, having before it the history of the former repeated abortive attempts to bring about a practical solution of the wet dock question, thinks it right to refer

to the event of the possible failure of the negociations above suggested. Should this occur, the Committee thinks that the East Indian Railway arrangements should be made as though a Chitpore wet dock were to be formed, and that the Government, or the Trustees of the Port of Calcutta, should, without delay, cause an exact estimate to be made by a competent Engineer of the probable cost of a wet dock of moderate dimensions, to occupy the site of the excavation formed for the East Indian Railway embankments. It will then be a matter for careful consideration whether the Trustees should enter on the construction of the dock, and its needful subsidiary buildings and works. Until an exact estimate is formed, no useful opinion on such a subject can be given ; and, as remarked before, in reference to the construction of jetties, it will be in all respects better that the Trustees of the Port should themselves bear the entire responsibility of the course they adopt in the way of dealing with this matter hereafter.

85. For reasons similar to those just given, the Committee has thought that no practical result will arise from any discussion of the details of any of the schemes for docks, jetties, or wharf walls that have been put forward by various Engineers. So far as the construction of jetties is concerned, the Committee has advised that private persons shall not be allowed to come in ; and the Trust for the Port, when it is constituted, should determine the exact character of the system of jetties undertaken, and what extension should be given to it. As regards docks, unless evidence is given of the desire of the promoters of such works to enter on their construction under arrangements that can be accepted by the Government, as not involving demands for assistance which are unreasonable, it seems better to wait until the results of the experiment that it is hoped will soon be made under the Trustees by the construction of jetties are seen. The real necessities of the port, and the powers of such a body as the new Trust to meet them, will then be better known, and a fresh point for departure will be given. All that the Committee can hope to do usefully is to deal with the present, and to indicate the measures that should now be taken.

86. Before concluding this report, the Committee will notice one or two points of minor interest that have come to their knowledge in the course of their enquiries.

87. The first has reference to the distribution of ships to particular moorings according to the character of their cargoes. The Committee is led to believe that considerable convenience would arise if some systematic arrangements were made with a view to accomplishing this so far as it is practicable, and it is suggested that the port authorities should be invited to consider the subject in communication with the Chamber of Commerce.

88. From the evidence of Captain Howe it would appear that there is room for upwards of 20 additional moorings in the upper part of the port, between Neemtollah Ghat and Chitpore, and that such moorings would be specially convenient for salt-ships. The attention of the port officers should, the Committee thinks, be directed to this point.

89. The next point relates to the supposed dangerous character of the approach to Calcutta up the Hooghly. Mr. Ross, a member of this Committee, has put in a statement showing the rates for insurance on ships homeward bound from Bombay and Calcutta, from which it appears that the charges are hardly greater for ships leaving the latter port than the former. The conclusion to be based on this seems to be, that the special risks of the Hooghly do not constitute a serious addition to the total sea risk between India and England. A return put in by Colonel Strachey from the records of the Public Works Department, based on information obtained by Mr. Leonard, confirms the opinion that the actual losses in the Hooghly are not important, viewed in relation to the whole extent of the trade. The losses for the last ten years have been less than three tons per thousand of the aggregate import and export tonnage, or little more than ¼ per cent.

Report of the Committee appointed to consider the question of constructing Wet Docks at Diamond Harbour.

From COLONEL S. T. TREVOR, R.E., Joint Secretary to the Government of Bengal, Public Works Department, to the HON'BLE. J. REYNOLDS, C.S., Chairman of the Commissioners for the Port of Calcutta,—No. 2995MPI, dated Calcutta, the 29th December 1881.

The Government of India has intimated to the Lieutenant-Governor that Her Majesty's Secretary of State for India has sanctioned the construction of a branch line from the Calcutta and South-Eastern Railway to Diamond Harbour, and has also accorded his approval to the formation of a Committee for the purpose of considering the question of constructing wet docks at Diamond Harbour in connection with the railway. The Lieutenant-Governor has accordingly selected the gentlemen named on the margin to form the Committee, with yourself as President; and I am directed to request that you will be so good as to place yourself in communication with the members and make all necessary arrangements for the assembly of the Committtee. The Superintendent of Marine has been requested to provide a steamer whenever you may require one to take the Committee to Diamond Harbour.

PRESIDENT.

Hon. H. J. Reynolds, C.S.,
Chairman of the Port Commrs.

MEMBERS.

H. C. Levinge, Esq., C.E.,
Secy. to the Govt. of Bengal, P. W. Dept.
Colonel S. T. Trevor, R.E.,
Jt. Secy. to the Govt. of Bengal, P. W. Dept.
Bradford Leslie, Esq.,
Agent to the East Indian Ry.
R. Steel, Esq.
G. H. Morrison, Esq.
C. Wawn, Esq., C.E.

2. In order to place before you clearly the subject upon which the Committee are required to deliberate, I am directed to explain that the question of constructing docks at Diamond Harbour is not a new one, but it is presented for consideration under prefectly different circumstances from those which prevailed before—in 1849, for instance, when the subject was carefully gone into by Government. Then the construction of docks was weighted by the necessity of constructing a railway. At present the railway to Diamond Harbour stands on its own merits, and is in fact in course of construction independently of the docks. At that time all merchandise landed at the docks would have had to be unpacked and warehoused at Calcutta prior to despatch to the provinces. But now a bridge is about to be built over the Hooghly which will connect the East Indian Railway with Calcutta and the other railway systems of Eastern Bengal. Goods landed at the docks could, when the bridge is built, be transferred direct from the ship's hold to the railway wagons which would take them up-country or to Eastern Bengal; and, similarly, goods for export and coal for the use of steamers could be run down and delivered at the ship's side. The main question which now remains for consideration is whether a wet dock at Diamond Harbour would be of such use and benefit to the shipping and trade of Calcutta as to make it a remunerative undertaking to Government or to a company; and, to arrive at sound conclusions on this point, it appears desirable that the Committee should pursue their investigations under the following heads:—

(1) The risks and delays to which ships are now liable in navigating the Hooghly above Diamond Harbour, and in lying in the open tideway of the river in case of storms and cyclones, and the extent to which immunity from such risks and delays can be secured by the construction of docks at Diamond Harbour, and the probable money value of such immunity. In connection with this subject, the Committee should consider whether it is not probable that the size of steamers frequenting the port is likely to increase, and whether, if this is so, the present appliances of the port will meet the requirements of the shipping.

(2) The present cost of bringing ships into the port, unloading and loading, and taking them out to sea again, compared with the like charges in the case of ships putting into docks at Diamond Harbour, and either loading and unloading, or partly loading and unloading there.

(3) The present railway and portage or other charges incidental to the shipment and unshipment of goods in the port as at present managed, compared with the like charges in case of goods being deliverable in docks at Diamond Harbour, and carried by rail over the extra distance.

(4) The advantages to be expected from the crossing of the Hooghly by the East Indian Railway to the port in its present position, compared with the possible advantages to be looked for if the railway be connected to docks at Diamond Harbour, which could be specially designed to afford every facility to the shipping, and plenty of room for expansion.

(5) The possibility of effecting a reduction in the general charges and port dues incurred by ships frequenting Calcutta, at the same time that greater facilities are afforded by the docks, and thus enabling Bengal to compete better in the markets of the world.

(6) The general design of the docks, their position and size, and probable cost—whether provision should be made for future extension—the protection to be provided against storm waves—whether it is better to utilise the creek at Diamond Harbour by converting it into a dock or to excavate new docks—the provision to be made for building-sites, for custom house, for bonded goods, warehouses, drinking-water, lighting, drainage and conservancy, &c.

(7) The general prospect of the docks proving a remunerative undertaking.

(8) In the event of the Committee arriving at conclusions which preclude them from recommending the project for docks, are there any other less important works which can be recommended for execution at Diamond Harbour, in view of the completion of the railway, such as coal wharves, jetties for passengers, &c.

In conclusion, I am to state that you are at liberty to obtain such evidence as may be procurable, documentary or oral, whether from Government officers or other gentlemen who may be willing to afford information. On all technical questions the Committee will be furnished with the necessary information by Mr. Wawn, who has been specially selected and appointed by the Secretary of State for that purpose, and who will prepare such designs and estimates as the Committee may require. Your report should be submitted to this office when completed.

Report of the Committee on Docks at Diamond Harbour.

PRESIDENT.

HON'BLE H. J. REYNOLDS, C.S.,
Chairman of the Commissioners for making Improvements in the Port of Calcutta.

MEMBERS.

H. C. LEVINGE, Esq, C.E., *Secretary to the Government of Bengal, Public Works Department.*	ROBERT STEEL, Esq., *Firm of Robert Steel & Co., of Calcutta.*
COLONEL S. T. TREVOR, R.E., *Joint Secretary to the Government of Bengal, Public Works Department.*	G. H. MORRISON, Esq., *Firm of Turner, Morrison & Co., of Calcutta.*
BRADFORD LESLIE, Esq., C.E., *Agent to the East Indian Railway Co.*	C. WAWN, Esq., C.E., *Special Engineer appointed to the Committee by the Secretary of State.*

SECRETARY.

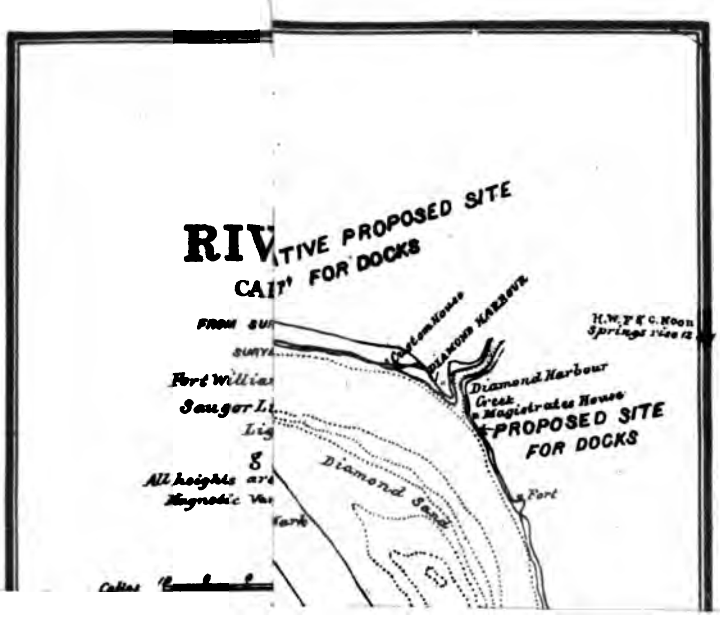
C. W. ODLING, Esq., C.E.,
Executive Engineer, Public Works Department, Irrigation Branch.

After the second meeting of the Committee, Mr. Steel left Calcutta and was replaced by

J. J. J. KESWICK, Esq.,
Firm of Jardine, Skinner & Co.

1. The Committee held meetings at the office of the Port Commissioners on the following dates: 10th January, 31st January, 24th March, 20th April, and 1st May 1882. They visited Diamond Harbour on the 25th January. All the members were present at every meeting.

G.f.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8
All heights are
Magnetic Va
Cables
TIVE PROPOSED SITE
FOR DOCKS
Custom House
DIAMOND HARBOUR
H.W.F & C. Noon
Springs rise 12 ft
Diamond Harbour
Creek
Magistrates House
PROPOSED SITE
FOR DOCKS
Fort
Diamond Sand
Mark

2. Mr. Wawn arrived in Calcutta on the 12th December 1881, and proceeded on the 15th of the same month to Diamond Harbour to make his preliminary examination of the site of the proposed docks. He subsequently visited Diamond Harbour on the 25th January, the 25th February, the 2nd March, and the 26th April. In the meantime he has been engaged in the preparation of the designs, which are submitted with this report and explained in his letter of the 4th of March.

3. Under Mr. Wawn's directions, trial wells and borings were sunk by Mr. White, Assistant Engineer, Diamond Harbour Railway. A well was got down dry to about 25 feet below the surface of the ground, or about 10 feet below low tide. At about this level water was first encountered, and at about 28 feet below the surface the earth fell from behind the timber backing, and the well was abandoned. A brick well is at present being sunk. Borings to a depth of 82 feet have been made in two places, the general result showing a mixture of silt and sand in varying proportions. In boring No. 1, at a depth of between 40 feet and 50 feet from the surface, where the proportion of sand was greatest, a considerable quantity of water also appeared to be present with it, but to what extent the water is likely to give trouble cannot be satisfactorily gauged until a well has been sunk through it. In boring No. 2 very little water was observed. The latest information on this subject will be found in Mr. Wawn's letter in the appendix, page V.

Proceedings of Committee.

4. At the first meeting of the Committee it was resolved, in order to obtain general information as a guide to more particular enquiries, that the Committee should draw up and circulate amongst merchants, shipowners, pilots, &c., a series of questions relating to the navigation of the river, size and expenses of vessels, general commercial facilities, &c.

5. Questions suggested by different members of the Committee after the first meeting having been collected, arranged, and printed, another meeting was held on the 31st January to consider them. They were then, as modified in Committee, corrected and issued to about 100 gentlemen, who, it was supposed, would be able to afford information, including the Port Commissioners, the Chamber of Commerce, insurance companies, &c., and a note explaining generally the scheme, as suggested by the Special Engineer, was circulated with the questions (see appendix, page xi).

6. A sufficient number of replies having been received, a meeting of the Committee was held on the 24th March to consider them, and to deduce from the evidence thus obtained the information to be set forth in the report. The names of the gentlemen who have favoured the Committee with replies are given in the margin, and their replies are printed in full in the appendix, pages xi to xliv. Besides replies to the Committee's questions, the gentlemen named on the margin* have also addressed letters to the Committee explaining their views more fully and generally: these are printed in the appendix, pages xlix to lvii.

7. At the meeting of the 24th March, the Committee considered also Mr. Wawn's letter of the 4th idem, printed at pages i to iv of the appendix, and examined Captain Yates, Harbour Master of Calcutta, more fully as to the replies given by him to the printed questions.

Messrs. R. Steel & Co.
,, Hoare, Miller & Co.
,, Mackinnon, Mackenzie & Co.
,, George Henderson & Co.
,, Gladstone, Wyllie & Co.
,, Ralli Brothers.
,, Prankissen Law & Co.
,, Jardine, Skinner & Co.
D. Scott, Esq., Vice-Chairman, Port Commissioners.
Captain Yates, Harbour Master.
Lieutenant Petley, R.N., River Surveyor.
,, Stiffe. I, N., Port Officer.
S. R. Elson, Esq., Master Pilot.
A. J. Milner, Esq., Branch Pilot.
G. H. Simmons, Esq., Secretary, Port Commissioners.
W. H. Grimley, Esq., Collector of Customs.
C. J. Wilkinson, Esq., Superintendent, P. & O. Co.
Captain G. S. Thomson.
F. Prestage, Esq., Agent, Eastern Bengal Railway.
Messrs. Bird & Co., Managing Agents, Burrakur Colliery.
R. M. Daly, Esq., Branch Pilot.
Messrs. Duncan Brothers.
Messrs. Apcar & Co.
A. B. Inglis, Esq.
Messrs. Gillanders, Arbuthnot & Co.
Chamber of Commerce.
J. R. Wells, Esq., Branch Pilot.

*Captain A. D. Taylor, I. N.
Lieutenant Stiffe, I. N.
C. J. Wilkinson, Esq., Superintendent, P. & O. Co.
Messrs. Hoare, Miller & Co.
Messrs. Ralli Brothers.
W. H. Grimley, Esq.
Messrs. Gladstone, Wyllie & Co.
R. M. Daly, Esq., Branch Pilot.
Messrs. Gillanders, Arbuthnot & Co.
S. R. Elson, Esq., Master Pilot.
W. Duff Bruce, Esq.
The Port Commissioners, enclosing a letter from J. R. Wells, Esq., Branch Pilot.

Review of previous schemes for improving the port.

8. Before proceeding to consider the opinions which have been collected on the scheme of docks now proposed to be constructed at Diamond Harbour, the Committee deem it advisable to review brifly the projects

which have been previously suggested with a view to improve the port of Calcutta. In a letter from the Bengal Chamber of Commerce, dated the 29th December 1858, reference is made to a proposal, dating so far back as 1824, for constructing wet docks in the neighbourhood of Calcutta; and in page 31, volume XXI of the Proceedings of the Institution of Civil Engineers, it is stated that in 1831 a survey was made by order of Government with a view to the excavation of a canal from Calcutta to the head of the Mutlah. This proposal for a canal was revived at various times, but eventually the matter was for the time decided by the construction of the Calcutta and South-Eastern Railway in its place.

9. In 1843 the Government of Bengal, in reviewing the proceedings of a Committee appointed to investigate the circumstances attending the loss of certain Government vessels during the hurricane of 1842, observed that the damage was chiefly due to the crowded state of the port, and pointed to the necessity of constructing wet docks with a view of preventing the occurrence of similar calamities in future. A Committee, with Lieutenant-Colonel Forbes, Bengal Engineers, as President, was appointed in May 1844 for the purpose of enquiring into, and reporting upon, the expediency of constructing wet docks capable of receiving the whole shipping of the port of Calcutta. The Committee reported strongly in favour of wet docks being constructed, and indicated the vicinity of Kidderpore as the one in most respects best adapted for the purpose. They recommended that the docks should be made of sufficient size to accommodate 200 vessels of an average burden of 400 tons, and estimated their cost at 50 lakhs of rupees. In 1847 an endeavour was made to float a company with a capital of one million sterling for constructing a line of railway to Diamond Harbour with warehouses and wet docks there. The project fell through chiefly owing to the impossibility of raising the capital, without a Government guarantee of a certain minimum rate of interest which was refused, but the doubt then existing as to the feasibility of introducing railways into India had also a share in this result.

10. The Chamber of Commerce, between 1858 and 1864, several times represented the inadequacy of the appliances of the port for the increasing number of ships frequenting it. In the letter dated 29th December 1858, before referred to, the Committee of the Chamber of Commerce state: "The time has now arrived when nothing less than the absolute possession of wet dock accommodation will satisfy the increasing requirements of the extending commerce of Bengal;" and in a subsequent letter, dated the 27th February 1863, they recommended to the favourable consideration of Government the construction of wet docks on a plan advocated by Mr. F. Prestage, then Chief Engineer of the Eastern Bengal Railway Company. In 1864 definite proposals for wet docks were laid before Government by Mr. Power of the East Indian Railway Company, and by Mr. Leith, Chairman of the Eastern Bengal Railway Company, representing respectively the Calcutta Victoria Dock Company, Limited, and the Calcutta Wet Docks and Wharves Company, Limited. Late in that year a Committee was appointed to consider this subject in connection with the proposed Hooghly Bridge and the junction of the East Indian and Eastern Bengal Railway Companies. The practical result of the report of this Committee was the creation of the Calcutta Port Trust, which has to a very large extent met the wants of the port up to the present time.

11. The improvement of the river itself has not escaped attention. In 1863 an attempt was made to improve some of the channels by means of a toothed roller, which was on the whole considered successful, and the subject was considered of such importance that Mr. Leonard, C.E., was deputed to visit the principal European rivers in the hope that some of the means used for training rivers in Europe or dredging apparatus used there might be adapted to the Hooghly. Mr. Leonard, supported by Sir C. Hartley, C.E., recommended the construction of a steamer fitted with rakes for the purpose of stirring the sands in the shoaler parts of the river and the construction of spurs at Moyapore. A steamer, the *Agitator*, was procured from England and commenced working in 1867. Although frequently laid up for repairs, she appears, on the whole, to have been of service. Doubts, however, were expressed whether the results were commensurate with the expense of working her, and the vessel being required for other uses, she ceased to be employed on this work in November 1869, though her dredging apparatus was ordered to be preserved for use in case of any emergency arising in future.

12. As regards the Moyapore Shoals, an estimate amounting to R2,42,000 for spur works for improving the channels there was sanctioned in February 1868; work was carried on at intervals up to June 1870, about two lakhs of rupees being expended without any decided improvement resulting. Mr. Robertson, C.E., was consulted in 1872, and recommended that

a training wall should be substituted for spurs, but the Chief Engineer did not concur in this view, which was not carried out.

13. The most determined attempt, however, to meet the constantly increasing trade of Calcutta was the creation of a new port (Canning) in conjunction with the Calcutta and South-Eastern Railway. Jetties were built on the River Mutlah, and a commencement was made in the way of providing warehouses. The capital expended was very large, but for several reasons, the most potent of which was perhaps the financial crisis of 1866, the scheme was not successful. There were, from the outset, grave difficulties attending the attempt to open this port; the place, like all new settlements near the Sunderbuns, was unhealthy; good water for drinking purposes was not to be had; the water in the river was believed to have a prejudical effect on the bottoms of iron ships; the river bank cut away rapidly, and one jetty erected by the Railway Company was so much injured by scour that it fell in; tug boats and other facilities were wanting, and the place got a bad name, which, added to the financial difficulties with which the Port Canning Company were then contending, led to the abandonment of a scheme which at one time was thought likely to solve all the difficulties connected with the shipping trade of Calcutta.

14. The presumed advantages of the River Mutlah over the Hooghly are, however, so great, that in 1876 the earlier project of connecting Calcutta and the Mutlah by means of a ship canal was again subjected to detailed examination. Mr. Dejoux, C.E., of the Public Works Department, after carefully investigating the whole matter, proposed a canal 30 miles in length with a width at surface of water of 250 feet and 28 feet deep. The canal was to be supplied by pumping from the Hooghly, the maximum lift being 17 feet, and to be provided with locks 600 feet by 60 feet. Its total cost was estimated at R1,54,58,344. Including interest at 4 per cent., a sinking fund of 3 per cent., and working expenses, an annual income of R16,56,788, equivalent, according to Mr. Dejoux, to 12 annas per ton *on all* shipping visiting Calcutta, would have been required to render the project financially successful. The estimated cost included four locks into the Circular Canals for boat traffic, but not wet docks at Sealdah, which, it was stated, would be necessary, unless an extra width was given to the last four miles of the canal, and masonry quay walls allowed on that length. The extra cost of these two items was estimated at one million sterling, on which a return was expected from loading and unloading charges. No serious effort was made to raise capital for this work.

These various schemes, completed or only suggested, go to show that the trade of Calcutta has for years back been struggling against recognised disadvantages.

Increase of trade.

15. But the trade of Calcutta has nevertheless made vast strides of late years. The following statement, extracted from the annual report of the Port Commissioners, gives the number of sea-going steamers and sailing ships that have annually entered the port during the last 20 years. The statement shows only the sea-going vessels which have been brought into port by officers of the Pilot Service, and excludes all river steamers and country boats :—

YEAR.	NUMBER OF VESSELS.			Net tonnage.
	Steamers.	Sailing vessels.	Total.	
1861-62	89	803	892	668,311
1862-63	118	816	934	699,040
1863-64	173	967	1,140	933,148
1864-65	187	1,019	1,206	997,756
1865-66	201	708	909	784,703
1866-67	175	599	774	682,848
1867-68	152	732	884	804,450
1868-69	208	679	887	839,823
1869-70	204	602	806	757,208
1870-71	259	672	931	889,229
1871-72	300	655	955	985,822
1872-73	338	615	953	978,621
1873-74	429	552	981	1,002,466
1874-75	454	473	927	1,016,706
1875-76	406	508	914	1,027,733
1876-77	552	609	1,161	1,352,155
1877-78	726	646	1,372	1,592,535
1878-79	489	478	967	1,115,392
1879-80	442	454	896	1,103,013
1880-81	506	478	984	1,220,546

16. The number and tonnage of steamers from European ports *viá* the Suez Canal are given in the following statement:—

Year.	Number.	Gross tonnage.
1871-72	87	156,583
1872-73	95	188,509
1873-74	118	266,960
1874-75	105	270,799
1875-76	145	360,586
1876-77	161	406,120
1877-78	171	417,604
1878-79	128	347,408
1879-80	136	365,578
1880-81	163	430.894

17. These statements show that the trade of Calcutta measured by tonnage has doubled itself in the last 20 years, and that it is passing gradually from sailing vessels to steamers. In 1877 and 1878 there was an abnormal increase of shipping in the port in consequence of the Madras famine. But setting this aside, if the number of Canal steamers that entered the port in 1880-81 be compared with those that entered in 1871-72, it will be seen that in 10 years the number has doubled, and the tonnage increased three-fold. But on the other hand, there has been a reduction in the number of sailing vessels during the same period from 655 in 1871-72 to 478 in 1880-81, although the total tonnage has remained almost the same. The net increase in tonnage in these 10 years has been from 985,822 tons in 1871-72 to 1,220,546 tons in 1880-81, which is nearly 24 per cent; and this increase has taken place while the railway system of Bengal has been in its infancy. It is only within the last five years that any advance has been made in extending railways in Bengal further than the original guaranteed lines. We have now the Northern Bengal system at work and the Tirhoot system and the Patna-Gya line. Further extensions are either actually under construction or will soon be commenced in Central Bengal, in Eastern Bengal, and in Western Bengal, to connect Calcutta with the Central Provinces. The prospect thus opened out of a further rapid increase in the trade of Bengal is very clearly indicated in a memorandum which has been furnished to us by our colleague, Mr. Bradford Leslie, and which we here quote:—

> If it be assumed that the trade of Bengal has nearly attained its final development, and that all further expansion of trade will be diverted to Bombay, there would be no sufficient cause for bringing the East Indian Railway across the Hooghly, or for considering the subject of docks at Diamond Harbour; but this is not the opinion of those who have studied the subject by the light of practical experience.
>
> 2. In gauging the progress due to railway enterprise it is usual to look at the net financial result, and in the case of the older guaranteed lines this is sufficiently startling, but a truer index of their utility would be the value of goods transported. Although it is impossible to give this, the tonnage carried affords some idea of its rate of increase.
>
> 3 Owing to progressive reduction of rates, the tonnage carried on nearly all the railways has increased in a much higher ratio than the net earnings.
>
> 4. The following statement exhibits separately the quantity of coal and all other goods received by rail at Howrah from the year 1871 to the year 1880, inclusive. Dividing the total period of 10 years into two of five years each, and taking the average of each five years, we arrive at the average increase of tonnage in a period of five years:—

EAST INDIAN RAILWAY.

Statement of Goods Traffic downwards from 1871 to 1880.

	Received at Howrah.	
	Coals.	Other goods.
	Tons.	Tons.
1871	185,969	192,533
1872	231,727	181,161
1873	292,873	219,733
1874	311,924	215,976
1875	293,796	295,818
	1,316,289	1,105,221
Average per year . .	263,257	221,044
1876	274,387	531,189
1877	308,484	738,273
1878	398,587	533,270
1879	389,450	543,501
1880	387,836	627,515
	1,758,744	2,973,748
Average per year . .	351.748	594.749

5. The increase on coal is 33 per cent. in five years, or at the rate of about 7 per cent. per annum, and this notwithstanding the first period includes the years 1872-73-74, when the Bengal coal trade was abnormally stimulated by the fancy price of coal in England.

6. The coal trade is at present much incommoded by the want of depôt accommodation at Howrah; but when the bridge is ready, this trade will receive a great impulse, and as prejudices are overcome, and the good steaming qualities of the finer descriptions of Bengal coal are better known, a slight reduction in its cost will ensure its use by ocean steamers, especially if facilities are afforded for loading direct into bunkers at Diamond Harbour. It is indeed probable that with the completion of the harbour at Madras, the railways there will find it more profitable to use Bengal coal than English "Patent Fuel," but arrangements would be necessary for loading screw colliers direct from the railway hoppers.

7. Comparing the average downwards goods, excluding coal, received at Howrah for the five years 1871 to 1875 inclusive, with the same average from 1876 to 1881, it appears that the tonnage of the ordinary railway traffic to Howrah is increasing at the rate of over 20 per cent. per annum, and most of it is for exportation.

8. The tonnage of downwards goods (excluding coal) received at Howrah during the year 1881 was 799,468: coal amounted to 392,340 tons.

9. The official returns of the internal trade of Bengal show that the enormous increase of railway tonnage has not caused any falling off in the boat and steamer traffic, the imports into Calcutta by all the routes of navigation showing a satisfactory increase; the explanation being that a large proportion of the boat traffic comes from districts north of the Ganges and elsewhere not yet provided with railway communication, and the great increase of railway traffic is brought from districts remote from navigable rivers and canals.

10. Considering that the construction of the proposed Central Provinces Railway will in a few years place Calcutta within a comparatively short lead by rail of the fertile districts of Sumbulpore, Raipur, and Chattisgarh, and the enormous districts north of the Ganges that will be placed in direct communication with the port of Calcutta by the extensions of the Tirhoot State Railway to Goruckpore and Bahraitch, the increase of traffic that will result from the completion of the bridge over the Ganges at Benares, the further ramifications and development of the Northern Bengal Railway system, together with the growing traffic of Assam and Cachar, the opening of the Bengal Central Railway, and the gradual reclamation of the Soonderbuns that is certain to ensue, there is no reason to suppose that the limit of railway traffic seeking Calcutta as its natural outlet has yet been distantly approached.

11. The East Indian Railway Co. is increasing its rolling-stock, and can still further reduce its rates, and by the year 1885, when the bridge, it is hoped, will be finished, the Agent confidently expects that this railway alone will be pouring in country produce, excluding coal, at the rate of 1,250,000 tons per annum, provided facilities are afforded for its export; for experience has proved the futility of stimulating traffic by cheap transport without proper accommodation for dealing with it at destination. Already, owing to insufficient shed-room at Howrah, the Railway Co. is compelled to unduly limit the free time for removal of consignments.

12. It may be contended that there is no advantage in providing for expansion of traffic which, owing to foreign competition or to dullness of demand, may never be realised. The reply to this is that with every advantage in the way of communications, India can only supply a fractional part of the requirements of the markets of the world, and that by the adoption of improvements in the transmission of her produce to market she should be in a position to command a sale for all her surplus.

13. The conditions under which India, and Bengal in particular, compete with the other grain-exporting countries are already very favourable. The climate, assisted by artificial irrigation, produces annually two crops—the khurreef and the rubbee—or the monsoon and cold weather crops. The former, generally speaking, supports the frugal, industrious, and teeming population, and the latter is available for exportation. Agricultural labour, both human and animal, is thus constantly employed all the year round, and does not spend half its time in unprofitable hibernation as in Russia and North America. The ryot in fact employs his capital, that is, his labour, continuously instead of intermittently. Again, the export of grain and seeds is favoured by the cheapness of inland transport by rail and river, and by abundance of labour for handling goods. Another favourable circumstance is that the jute sacks required for shipment of these staples are produced locally and have a high market value at the port of destination, so that instead of heavy capital outlay for elevators, machinery, and special stock for the unsatisfactory system of dealing with the grain in bulk, there is a certain profit on the very sacks necessary for carrying the grain.

14. With all these advantages, Bengal should be in a position to export produce at rates which cannot be approached by any other country in the world, but for this purpose the trade must be supervised throughout by European agency. Under the existing system, in which the trade in country produce (excepting cotton, indigo, tea, and a few other staples) is chiefly in the hands of natives, a considerable percentage of the freight paid to railways is for the carriage of dirt, and produce unfit for export, and the losses through rotten bags, exposure to the weather, and pilferage are considerable. To obviate these losses, European produce agents have established themselves at the provincial depôts, who clean and bag the grain for direct shipment. There is no doubt that the dry climate of the interior is more favourable for the storage and preparation of grain and seeds than the humid atmosphere of the tropical seaports, and that, for the delivery of country produce in good order at the port of destination, the shorter the time it is exposed to the damp air of Lower Bengal the better.

15. It may not be out of place to point out that a regular export of food-grains is the best insurance against famine. Where grain is grown for export, stocks are held in anticipation of improvement in the market rate, and the failure of the crops in one district can be supplemented by diverting the export produce from other districts. If this is the case, the construction of the proposed docks at Diamond Harbour, which would do more than anything else to facilitate this trade, may be regarded as to some extent a work for insurance against famine.

> 16. The question then arises, will the existing shipping accommodation in the port of Calcutta be sufficient to deal with the increased traffic the railway will be in a position to bring into Calcutta when the bridge is finished? The change from small timber ships to iron ships and from sailing to steam vessels, and the improvements effected by the Port Commissioners, have provided for the increase of traffic in the last ten years; but it is admitted that to provide for any further considerable increase of the export trade, additional accommodation is necessary, and it is certain that unless such accommodation be provided, the advantages to be derived from the crossing of the Hooghly by the East Indian Railway will not be fully realised. How and where such additional accommodation should be provided so as to secure the best facilities to trade is the subject to be considered.
>
> 17. With the docks at Diamond Harbour entire cargoes of grain and seeds and other produce could be brought down by rail and transferred direct from the railway wagons to the ship's hold, and this service could be undertaken by the Railway Company without the necessity for any other agency.
>
> 18. The reduction of the duty on salt will have the effect of sending the Liverpool salt further up-country into districts not reached by boats, and if the Government salt depôt be transferred to docks at Diamond Harbour, the facility of loading direct into railway wagons would result in very largely transferring this traffic from boat to rail, thereby reducing the opportunities for smuggling, and giving the railway a back load for its stock.
>
> The site of the existing golahs at Sulkea is valued at many lakhs of rupees.
>
> 19. Naturally any proposal tending to dispense with intermediate agencies will be unfavourably received by those interested, but that does not affect the question under consideration. The East Indian Railway takes delivery of heavy consignments of railway material of every description not only for its own use, but also for the Oudh and Rohilkhand and State Railways, and no difficulty or complications are experienced in doing this work at very low rates even with the present imperfect appliances. With docks at Diamond Harbour these materials could be despatched direct to destination or to a mofussil depôt where they could be economically stored until required. There is no reason why the Railway Company should not in the same manner receive general cargo ex ship and deliver it to order of consignee.
>
> 20. Assuming that the proposed site for the docks at Diamond Harbour is open to no insuperable objection from an engineering or nautical point of view, and that satisfactory arrangements can be made for running powers over intervening lines of rail, the Agent of the East Indian Railway would not hesitate to recommend their construction and incorporation as part of the undertaking.

18. In the opinion that a large increase in the accommodation of the port of Calcutta will soon be an urgent necessity, the Committee is unanimous. But when we proceed to the consideration of the question how and where such additional accommodation should be provided so as to secure the best facilities to trade, we find that the evidence which we have collected shows a great preponderance of opinion amongst the merchants of Calcutta in favour of some scheme which will avoid the removal of the shipping from the present limits of the port. This view is, moreover, advocated by two of our colleagues. But the majority of the Committee, after a careful consideration of all the evidence in favour of the proposal to construct docks at Diamond Harbour, as well as all that has been urged against it, are of opinion that that is the most practicable scheme which has yet been proposed, and the one which offers the best prospect of financial success. We therefore proceed now to consider that scheme in detail and in the order indicated in the letter of instructions from the Government of Bengal.

Risks above Diamond Harbour.

19. The chief dangers to which vessels are exposed in the Hooghly are very fully described at pages vi to xiv of the appendix, in the answers received to the Committee's first question. Those above Diamond Harbour may be summarised as shifting sands, narrow channels with sharp bends, eddies, and the want of good anchoring places. Owing to the volume of water passing through the narrow channels above Diamond Harbour, the risks are intensified during the freshets, and particularly at spring tides. The points of greatest danger are the James and Mary and Moyapore sands, the bad anchorage at Ninian and at Fisherman's Point, and the difficult navigation off Monekhally and Fulta Points.

20. The following extracts relate to the navigation above Diamond Harbour. Mr. Milner says: "The Muckrapatha Sand of the James and Mary is one of the most dangerous sands in the Hooghly, and the periodical closing up of the Eastern Gut in the months of March, April, May, and June often causes very serious delay." Mr. Elson also describes how these channels open and close with the season, and says "the closing of the James and Mary takes place at that season of the year when the mean half tide level of the river is low, and consequently deep-loading vessels requiring over 22 feet have sometimes had to go to Diamond Harbour to finish loading at such time." He says further that "fortunately the James and Mary has been good of late years, so that much inconvenience has not been felt." Mr. Milner says: "Ninian is a most dangerous place as an anchorage, especially in the freshets, on account of the strong eddies both on the flood and ebb tides, causing a ship to become quite uncontrollable and heeling her gunwale under on a strong shear if the cable will hold;" and Mr. Elson says: "Ninian is a forbidden anchorage for all vessels." Mr. Elson gives the

names of *ten* vessels lost within the last 20 years between the James and Mary and Fisherman's Point, and says that during this time only *sixteen* have been lost below the James and Mary; thus showing that out of 26 wrecks in the 110 miles of river below Fisherman's Point, 10 occurred in the dangerous shoals in the short space of 8 miles between that point and the James and Mary. Fewer accidents appear to have occurred lately; for, whilst Mr. Milner says that Fisherman's Point is "dangerous on spring tides and in the freshets," and that it was here that the steamship *Queen Anne* was lost, he goes on to say that to his knowledge this is the only steamer lost here since the opening of the Suez Canal, and that it was in charge of a Junior instead of a Branch Pilot. Mr. Milner says: "Moyapore Flat is a dangerous obstruction on account of its liability to sudden changes. Many ships ground here." Mr. Elson says: "Monekhally Point and the usual sand below it is, on account of the whirling eddies found off it, on the ebb tide a formidable danger to vessels passing down on the springs or in the freshets;" and on the same subject Mr. Milner says "the river off Monekhally Point on spring tides in the freshets is a place that is much dreaded on account of the uncontrollable eddies, and it is undoubtedly a relief to the pilot on the way down to find himself safely pass this place. Vessels, however, seldom ground on the sand, the tendency being to run on the southern bank near the crossing mark." Mr. Milner remarks generally that "in terminating the voyage at Diamond Harbour, there would undoubtedly be much less risk of accident, principally to sailing ships."

21. Other nautical gentlemen mention the same points of danger without going into details. Captain Yates says: "The advantages gained by the construction of the docks would be the avoidance of eddies principally above Diamond Harbour, of the narrow navigation of the upper reaches, of anchoring in the narrow channels, which are dangerous in freshets." Captain Wilkinson speaks of the risks to "a long ship rounding Hooghly Point on a strong flood tide, or in going down the river during the freshets, when she has very often stranded at Fisherman's Point." Lieutenant Stiffe says that "to have to anchor at a place like Fisherman's Point during the freshets is highly undesirable." The following standing order to pilots is significant: "Within three days of the full or change of the moon, no sailing vessel drawing more than 12 feet shall attempt to pass the James and Mary inward-bound on the flood tide, unless in tow of a steamer," and "vessels may not be under weigh at night between Gewankolly Temple and Fultah Point, or over the James and Mary under any circumstances."

22. And yet with all these acknowledged dangers the casualties have been comparatively few, and this must doubtless be attributed to the general efficiency of the Pilot Service, the rigid order about sailing at night, and the fact that vessels are content to wait occasionally at Calcutta for favorable opportunities for sailing.

23. From a special report of the Port Officer, dated 5th May 1881 (appendix, page xlv), it appears that whilst the number of total losses (omitting collisions) during the last *ten* years have been *two* above Diamond Harbour and *seven* below, the number of groundings in the last three years have been *ninety-six* above Diamond Harbour and *twenty-one* below.

Risks below Diamond Harbour.

24. Many dangers to navigation exist also below Diamond Harbour, in the Middle Ground Shoal, the encroachment of the Middleton Sand on to Saugor Roads, the heavy swell sometimes felt in the Gaspar Channel, and the shifting nature of the sands between Saugor and Kulpee. To this must be added of course a considerable portion of the risk caused by rough weather in the shallows and narrow channels off the Sandheads. There are places below Diamond Harbour with no greater depth of water than above; indeed, during the freshets, the channels above are generally the deeper of the two. The channels below Diamond Harbour, however, are generally wider and not so tortuous.

Delays above Diamond Harbour.

25. The loss of time to which vessels are subject above Diamond Harbour, including both the actual time required to steam or tow 50 miles each way, and the incidental delays to which they are liable, has been variously estimated, and as it depends greatly on the season, the state of the tide, the size and speed of the particular vessel, it is difficult to arrive at more than a rough average approximation. Messrs. Geo. Henderson & Co. think the saving would be only a "few hours, and of no practical value." Captain Wilkinson says: "Vessels are sometimes neaped inward-bound, and have had to wait as much as two days at Diamond Harbour." Mr. Elson says: "Half a day, and sometimes a day, would be gained by terminating the voyage at Diamond Harbour." Captain Yates says: "Ships and steamers from four to five hours up, and frequently one day

down." Also, "I have known instances in the dry season of P. and O. steamers outward bound going to Diamond Harbour two or three days before their date of sailing on account of the James and Mary shoal on falling tides. This has not occurred for some years." Mr. Daly says: "Ships would be saved one or two days and steamers one day at least." Messrs. Duncan Brothers say: "Steamers one day up and down, sailing ships two days up and down." Lieutenant Stiffe says: "Four hours up, one day down for large vessels, if not, six hours." Messrs. Jardine, Skinner & Co. say: "Half a day inwards and one day outwards. More in April, May, and June." Captain Thomson says: "Sailing vessel one day, steamer half a day." Messrs. Hoare, Miller & Co. say: "One day up and half a day down for a steamer." Messrs. Gladstone, Wyllie & Co. say: "Little more than three or four hours each way, for both ships and steamers." Mr. Grimley says that "the saving in the upward passage would be three and a half hours for a steamer and five for a sailing vessel; but a large vessel might be neaped and detained four or five days."

26. Although it appears from the report of the Port Officer, dated 5th May 1881 (appendix, page xlv), that only six vessels were actually neaped in the river during the last three years, it is well known that a large number of vessels might arrange to leave port earlier than they actually do, if they were not obliged to consider the water available in the river.

27. As a recent instance of the delays in the river, may be mentioned the *Vega*, drawing 23 feet 6 inches, which the Committee have ascertained left Calcutta on the morning of the 15th March 1882, and did not reach Saugor until the evening of the 17th.

28. Excepting coasting vessels, the Committee consider that the saving of time may fairly be set down for the double passage at one day for a steamer and two for a sailing ship.

Risks at moorings in the river.

29. Vessels moored in an open river are exceptionally exposed to risk of injury, more or less serious, particularly in times of strong tides, bores, and freshets, being liable to collision with vessels which have broken from their moorings, and with other floating objects. During cyclones immense damage is done; the great cyclone in the Hooghly (1864), it is said, costing the P. & O. Company alone upwards of £100,000.

30. Vessels in any ordinary dock are exempt from many of these risks, and the Committee believe that in the docks, as designed by the Special Engineer, they will be secure also from the effects of a cyclone wave, even higher than that of 1864.

Costs of risks and delays.

31. It is difficult to fix at a money value the saving which would be effected by eliminating the various risks and delays inseparable from the passage from Diamond Harbour to Calcutta and *vice versâ*, although there can be no doubt that it does represent an appreciable amount either to the merchant, shipowner, or insurance company, and probably more or less to each of them. Perhaps it will be the simplest way to assume that all the expenses of the voyage are to be paid directly or indirectly by "cargo," and that the direct interest of each individual engaged in the transport of the cargo from the one point to the other will arrange itself by the ordinary course of competition.

32. The replies which the Committee have received to questions on this subject do not give the complete information which we could have wished to obtain, but the size and value of the vessels and the requirements of the different trades all vary so greatly that it is perhaps difficult to see how it could well be otherwise.

33. The value of the one day and the reduced distance gained, in the case of a steamer of 3,000 gross register and carrying 3,700 tons of cargo, appears to be fairly represented as follows:—

	R
One day's internal expenses	200
Eighteen tons of coal, say	324
Pilotage saved (having paid $\frac{8}{12}$ up and $\frac{7}{12}$ down)	411
One day's insurance, depreciation and interest on capital, say 22 per cent. on £50,000	360
TOTAL .	1,295
Add in the case of a passenger vessel one day's victualling, say £20 . .	240
GRAND TOTAL .	1,535

34. The value of the two days and the reduced distance, in the case of a sailing ship of 1,600 tons register and carrying 2,400 tons of cargo, may be safely stated as follows :—

	R
Two days' expenses	160
Pilotage saved (as above)	372
Towage up and down	1,200
Two days' insurance, depreciation and interest on capital, say 20 per cent. on £23,000	302
	2,034

35. In addition to the towage between Diamond Harbour and Calcutta, a sailing vessel will frequently save also the cost of towage from the sea to Diamond Harbour. Mr. Milner says that "all sailing ships up to 20 feet would endeavour to sail up to Diamond Harbour is that were their destination, and even ships over that draught, if not prohibited by the regulations." And, again, "These ships at present would sail up to Diamond Harbour were it not for the knowledge that they would have to pay nearly as much from there as from Saugor. Saving of towage to the *Cuba, Simla* class both ways probably R3,000 to R3,500." These are, however, exceptional vessels, but it appears very clear that the greater part of the money now paid for towage might be saved if a sailing vessel could terminate her voyage at Diamond Harbour.

36. It appears to be generally conceded that there would be no appreciable reduction in the rate of insurance on ships frequenting the dock, but if the voyage were shorter, the risk would of course be reduced by one or two days, as the case might be.

Size of vessels frequenting the port.

37. The annual returns of the Port Officer for 1880-81, extracts from which, with diagram are given in the appendix, pages xlv. to xlviii, show the size of both ships and steamers frequenting the port is steadily increasing, and we have not to look far for the reason. The big ships pay best. Captain Wilkinson says: "It has been sufficiently proved to the satisfaction of all shipowners that the larger a ship is built, with reference to the trade she is employed in, the greater will be the profits in proportion to the capital expended." Messrs. Apcar & Co. say: "The tendency is to increase the size of steamers owing to the less proportionate expense of a larger vessel."

38. There appears to be a very general agreement amongst nautical men that some of the vessels which now come to Calcutta have, in point of length, about reached the maximum which can be safely navigated above Diamond Harbour. Below that point it is practically conceded that there need be no limit to length. Long vessels are not perhaps, strictly speaking, more *difficult* to steer than shorter ones, but they require both more space and more time to turn through a given curve. For steamers up to Calcutta, 400 feet in length is considered a reasonable limit by Captain Wilkinson, Captain Thompson, Mr. Daly, Mr. Elson, and Captain Yates. Mr. Milner goes further and says 450 feet, and as a matter of fact, vessels 420 feet long have come to Calcutta. Messrs. Jardine, Skinner & Co. call attention to the steamers of the Hill line. Their extreme length is 420 feet, but their twin screws facilitate navigation. The rapid and certain action of steam steering gear has done much to counteract the difficulty which would otherwise have been experienced with vessels of the present length, and it is possible that without it some of them could only have been brought to Calcutta with the assistance of a tug-boat. It may be mentioned that the *Rome*, one of the last new vessels of the P. and O. Company's fleet, is 430 feet long. It must, however, be borne in mind that some reaction is manifesting itself in ship-building against extreme length. A tendency is being shown to increased beam, and so far as this may go, it will enable ships to carry more cargo without increasing either length or depth.

39. For sailing vessels, from 250 feet to 300 feet appears to be generally allowed to be the greatest length which can without risk be taken above Diamond Harbour.

Facilities within the port.

40. Till within the last 12 years there were no jetties, wharves, warehouses, or appliances available generally for loading and unloading vessels in the port of Calcutta. Vessels were moored in the river and cargoes were discharged and taken in by means of cargo boats. The Port Trust was established in 1870, and since then great facilities have been provided by the construction of jetties supplied with suitable goods sheds, hydraulic and steam cranes, and a line of tramway in rear of the jetties connected with the Eastern Bengal Railway. There are now eight of these jetties, and the following

statement extracted from the annual report of the Port Trust shows the extent to which they have been annually utilised since their first construction:—

PERIOD.	No. of jetties.	No. of vessels accommodated.	Registered net tonnage.	Total number of days occupied at all jetties.	Total amount contributed by vessels for use of jetties.	Average tonnage of vessels.	Average length of stay at jetties.	Average number of days each jetty was at work throughout the year.	Average amount paid by each vessel for use of jetty.	Total jetty receipts for imports and exports.	Average per vessel.
					R				R	R	R
November 1869 to October 1870.	4	75	. .	. .	. .	. .	. .	. .	. .	. .	. .
October 1870 to March 1871.	4	51	66,359	485	. .	1,301	9·3	. .	. .	. .	. .
1871-72 . .	6	143	222,446	1,363	22,900	1,555	9·4	277	160	3,63,146	2,539
1872-73 . .	6	160	264,536	1,433	27,305	1,653	8·9	239	170	4,05,901	2,537
1873-74 . .	7	154	211,238	1,421	29,652	1,371	9·2	203	192	4,21,774	2,739
1874-75 . .	7	142	209,808	1,590	32,570	1,477	11·2	227	229	4,82,143	3,395
1875-76 . .	7	156	246,304	1,455	31,230	1,578	9·3	234	208	5,42,663	3,479
1876-77 . .	7	192	304,218	1,958	40.505	1,584	10·2	280	204	5,95,442	3,101
1877-78 . .	7	232	355,634	2,379	63,555	1,533	10·3	342	398	7,71,825	3,327
1878-79 . .	7	184	294,717	1,994	83,517	1,601	10·8	285	464	6,60,106	3,588
1879-80 . .	7	192	315 263	1,944	73,407	1,643	10·1	277	382	6,56,409	3,418
1880-81 . .	8	193	324,187	1,952	73,762	1,680	10·2	248	382	7,14,189	3,700

These jetties and their appliances for loading and unloading are all of the latest approved types of construction, and admirable in all respects. If there were room in the port for extending them from time to time to meet the growing trade, it seems probable that such a course would be adopted in preference to taking up new ground for docks at a distance from Calcutta, and that merchants would be content to trust, at all events till the growing size of vessels exceeded the draught available in the river, to the acknowledged skill of the Pilot Service to overcome the dangers of the navigation of the Hooghly. But the jetty accommodation is not really sufficient even for the existing trade of the port, and the evidence we have collected shows that, although room might be found for some extension, yet it is very doubtful whether the space available in port could be made adequate at any reasonable cost to meet the increased trade that will be brought to Calcutta by the opening of the railway bridge over the Hooghly and the extension of railways in Bengal. On this subject we would refer to Mr. W. Duff Bruce's letter at page xlix of the appendix, than whom there is no more competent authority on any matters connected with the port of Calcutta. In this letter Mr. Bruce, after describing the extent of increase that is possible to the present jetties, proceeds to develope a scheme of docks at Chitpore connected by a ship canal with the Mutlah River. This scheme, with other proposals, will be referred to further on. But in this place the Committee wish merely to describe the nature of the appliances for loading and unloading cargo which are available in the port. The table given above shows that 193 vessels, with a net tonnage of 324,187 tons, were accommodated at the jetties in 1880-81. Comparing this with the total number of vessels with their net tonnage that entered the port in the same year, we see that 791 vessels, with a net tonnage of 891,359 tons, did not or could not make use of the jetties, and must therefore have discharged and taken in cargo by means of cargo boats. Of these cargo boats there were 5,548 in the port in 1880-81. As to their charges and the extent of reliance that can be placd on them, we will here quote from Messrs. Hoare, Miller & Co.'s letter at page lv—

> " Amidst the many advantages which the jetties have conferred on the trade generally, but chiefly on import trade, there has been this disadvantage, that they have interfered with the boat-owner's business. The jetties have disorganised the private discharging and loading arrangements of the port without having so far furnished a complete or perfect substitute.
>
> " For practical purposes the jetties are sufficient for the import trade. Almost all the vessels which enter from the United Kingdom with general cargoes can be discharged rapidly at the jetties, and, even in time of extra demand for space, steamers can load their export as rapidly as they discharge their import cargo; but this only refers to general or ' Calcutta assorted ' cargoes. It does not include whole cargoes outwards.
>
> " The export cargo from Calcutta is bulkier than the import cargo. With very few exceptions, every vessel that clears from Calcutta clears full. On the contrary, many vessels, notably steamers, enter in ballast. Now, it seems to us that the arrangements of the port stand as if just the contrary were the case: vessels can discharge quickly, and we think cheaply, whereas for loading they mainly depend on cargo boats.
>
> " During periods of excitement in exports, such as periodically occur, the cost of putting cargo on board vessel at moorings often becomes enormous. We have known the hire of cargo boats of 25 tons capacity, which is normally Rs. 6 per day per boat, advance to Rs. 120, and remain at from Rs. 40 to 60 for weeks together. This is as if the jetties were, in times of pressure, to raise their rates at will from 400 per cent. to 600 per cent. The export trade is not a steady trade. Periods of excitement occur chiefly in the bulky staples."

Cost of bringing ships to port.

41. It will be evident from this that it is impossible to make any reliable estimate of the cost of loading and unloading vessels which are dependent on cargo boats; and, as has just been explained, by far the larger number of vessels are thus dependent. But the jetty charges are known, and may be included in the estimate which we now proceed to make of the present cost of bringing ships into port, unloading and loading and taking them out to sea again, compared with the like charges, in the case of ships putting into docks, at Diamond Harbour. It is necessary, in the first place, to ascertain what will be the working expenses of the dock, in addition to interest on capital, and the lowest remunerative charge to be made against each ship.

Annual Charge on Dock.

	R	R
Interest on estimated cost, including establishment, 150 lakhs, at 4 per cent.		6,00,000
Staff—		
Dock Master	15,000	
Two assistants	15,000	
Say 200 men (at Rs. 20 per month)	48,000	
European mechanic in charge of machinery	6,000	
Proportion of general staff, say	12,000	
		96,000
Dredging	50,000	
Electric lighting	12,000	
Repairs, average say	25,000	
Coal	12,000	
		99,000
		7,95,000
Deduct rent of sites let for workshops, houses, &c.		45,000
Net annual charge		7,50,000

Estimate of Revenue.

Vessels in dock at one time.	Vessels per annum.	Tons per annum
Say 6 steamers (2,600 average tonnage), each remaining in docks *two* weeks or less	156	405,600
Say 36 sailing ships (1,350 average tonnage), each remaining in dock six weeks or less	312	421,200
Total vessels	468	
Total tons		826,800

$\frac{\text{Revenue required R } 7{,}50{,}000}{\text{Total vessels } 468}$ = about R1,600 per vessel (average), or $\frac{\text{R } 750{,}000}{\text{Tons } 830{,}850}$ = about 14½ annas per register ton, or approximately 5 annas per ton of cargo inwards, and 5 annas per ton of cargo outwards. These charges are intended as an average to cover all dock dues, wharfage, landing charges, &c., and would be apportioned under different heads, but they would not include crane-hire or warehouse rent.

42. Cost of bringing to Calcutta a steamer of 2,000 tons net, 3,000 tons gross register, carrying 3,700 tons of cargo, and drawing 22 feet of water in and 24 feet out—

	R	R	R
Inwards—			
Pilotage	470		
Lead money	16		
Port dues at 1 anna	129		
Hospital dues	129		
Harbour Master	57		
Moorings	195		
Jetty charges	385		
		1,381	
Outwards—			
Pilotage	614		
Lead money	16		
Harbour Master	57		
		687	
Stevedorage 4 annas in, 4½ annas out		1,966	
Total for Calcutta			4,034

much larger number that discharge into cargo-boats and suffer delays and inconveniences, of which we can form no estimate, have not been brought into the comparison at all. The figures show that sailing ships will be the chief gainers by using docks at Diamond Harbour, in the mere initial saving that will result from the shortening of the voyage. But they will be still greater gainers by the saving of time in being able to discharge their cargoes into the dock warehouses at once, and take in export cargo with similar rapidity.

Objections to distance of Diamond Harbour considered.

48. We proceed now to consider the question of the distance that separates Diamond Harbour from Calcutta, and it is in connection with the effect which this distance will have on the success of the scheme that the greatest diversity of opinion exists. It is necessary to consider this question in two aspects—(1) with reference to the cost of transit for the extra distance over which goods will have to pass; and (2) with reference to the inconvenience entailed by the separation of the shipping from the mercantile offices in Calcutta.

49. As regards the first point, we believe that no appreciable increase of cost in transit will occur. The docks at Diamond Harbour would be specially useful for the export trade, and we have every reason to believe that goods from up-country would be delivered by rail at the docks at through rates, which would be very little, if at all, higher for Diamond Harbour than they would be for Calcutta. For any classes of goods which could be thus transported direct to the docks without the necessity of detention and examination in Calcutta, there would be an immense gain, for they would be delivered from the railway wagons into the ship's hold, and all intermediate charges now incurred in the handling and conveying of goods, first from the railway to the warehouse, and again from the warehouse to the ship's side, would be saved. And again, as regards the transit of goods from Calcutta itself or its neighbourhood to Diamond Harbour, for which a charge would necessarily have to be made, we believe that (under such a system as is described in the next succeeding paragraph) that charge would not be greater, and that it would probably be less than the expense now actually incurred in moving goods by the very imperfect means of transport afforded by country carts and boats from the merchant's godown to the ship's side. It cannot be doubted that the railway administration in connection with the docks would make such arrangements as would afford the greatest possible facility for the collection, despatch, and delivery of goods, and that the saving thus effected would constitute a substantial percentage on the value of export produce.

50. Proceeding to the consideration of the question of the inconvenience of Diamond Harbour, if we assume the existence of docks at that place, it appears to us to follow naturally that it would be to the interest of the proprietors of the docks and of the railway to afford every facility to trade. Sooner or later the docks and the railway would be under the same administration, and then undoubtedly a complete agency would be established for the receipt and delivery of goods. Suitable premises and warehouses would most certainly be provided at one or both ends of the railway,—*i. e.*, at Calcutta and at the docks,—where all such operations as examining, cleaning, sorting, packing, and marking could be executed at a comparatively small charge, and at much greater convenience to the merchant. As evidence of the probability of this view being realised, we would refer to the fact that the Port Commissioners have proposed to build a tea warehouse within the jetty premises which will be available for the storage, sampling, sale, and shipment of tea. We would also refer to the recommendations of the Committee lately appointed to discuss the question of a central railway station in Calcutta. We understand that they proposed the erection of a goods depôt at Halsee Bagan alongside the Circular Canals, connected with the trunk lines of railway and with the Port Trust and Diamond Harbour Railways. The area proposed to be acquired for the central depôt is 189 acres, with a frontage of 8,250 feet on the canal. It would thus be in direct communication with Diamond Harbour both by rail and by canal, if, as we recommend at the conclusion of this report, the canal be extended to meet the docks.

Mr. Bruce's scheme considered.

51. Before we proceed to express our opinion of the Diamond Harbour scheme generally we think it desirable to review as briefly as possible the alternative scheme which has been recommended by Mr. W. Duff Bruce, the Vice-Chairman of the Port Commissioners, now absent on leave. The Mutlah Ship Canal scheme, as now brought forward by him (appendix, page xlix), deserves careful consideration, for if it, or some modification of it, could be conveniently carried out, and at a reasonable cost, it appears to be capable of providing trading facilities equal to any which may be expected from docks at Diamond Harbour. We recognise Mr. Bruce's difficulties in being at a distance, and can only regret that he has not been able to go more fully into the details

of the project, for in attempting to consider the matter, however superficially, we are obliged to assume many important particulars which are not even alluded to by him.

52. The chief features in this scheme are—

(1) To remove the Howrah Bridge to the north of the Neemtollah Ghât

(2) To dredge a ship canal from Chitpore to a point about six miles below Port Canning on the Mutlah River. The canal to have generally the section of the Suez Canal, and to be deep enough for vessels of from 33 to 25 feet draught of water.

(3) To construct a lock at the junction with the Mutlah.

(4) To construct a dock near Sealdah, apparently about the size of that suggested for Diamond Harbour.

(5) To connect the canal with the existing canals around Calcutta, and

(6) To make a "cut" from the dock to the Hooghly River.

Certain other details appear to follow as a matter of course, such as—

(7) The construction of a lock somewhere between the dock and the Hooghly.

(8) The construction of opening bridges at two places where railways, and at least two other places where main roads, must cross the canal.

(9) The provision of ferries at suitable places along the length of the canal; and

(10 The closing of the Pialee River and other water-courses in the line of the canal.

53. In attempting a rough estimate of the whole of the suggested works, we have assumed that the level of the water in the dock and canal is to be maintained by means of the locks at the same level as that in the present Circular Canal, with which it is to be connected,—*viz.*, about 6 feet above mean sea-level, or at about 4 feet below the ordinary level of the ground. We have assumed the latter to be about the same as at Diamond Harbour, and that the sections of the canal will be similar to that of the Suez Canal, *viz.*,—72 feet wide at the bottom, with sides sloping 2½ to 1. The amount of material to be excavated or dredged to form the canal and "cut" will amount to about 6,500 lakhs of cubic feet. We accept Mr. Bruce's estimate (£750,000, or about R14 per thousand feet) as being approximately correct for this portion of the work, though whether it be sufficient or not must depend a good deal on the distance to which the spoil may have to be carried.

So far as we are in a position to estimate from the data at our command, the total cost of the suggested works, exclusive of the purchase of the land, would probably be about as follows :—

	Lakhs.	Lakhs.
Dredging canal and cut (£750,000)	90	
Removal and lengthening of bridge and provision of new approaches, say	6	
Lock at Mutlah	14	
Well foundation for ditto	11	
Dock	32	
Lock at Hooghly	14	
Wells, foundation for ditto	11	
Pitching slopes of canal	15	
Four opening bridges, each with 80 feet clear water passage, including cylinder foundation and piers, girder approaches over the inclined sides of the canal, and all machinery, &c., say, average 5 lakhs each	20	
Diversion of railways and roads during construction of bridges, say .	2	
Ferries, say	0·5	
		215·5
Contingencies, say 10 per cent.		21·5
Assumed total for a draught of 25 feet, exclusive of land		237

54. Admitting for a moment the scheme to be feasible on financial and other grounds, there are two points in which, in our opinion, certain modifications would be necessary, both tending to increase the cost of the undertaking. We consider that, by limiting the canal to the use of vessels not exceeding 25 feet draught of water, its utility would be to a great extent neutralised, seeing that we have it in evidence that vessels drawing 26 feet have lately come

to Calcutta. Looking to future requirements, and making allowance for a certain deposit of silt, the canal at the outset should not be less than 28 feet deep. We also consider that, to guard against the possibility of the larger vessels being either imprisoned in or cut off from Calcutta in the event of repairs to the gates, &c., the locks, or at least that at the Mutlah end of the canal, should be in duplicate. These additions bring up the estimate to—

	Lakhs. R	Lakhs. R
Dredging as before	90	
And for extra depth	13	
	—	103
Removal of bridge as before		6
Lock at the Mutlah	14	
Duplicate	14	
	—	28
Wells for lock	11	
Do. for duplicate	11	
	—	22
Pitching slopes of canal		15
Dock (3 feet deeper)		37
Lock at the Hooghly		14
Wells for ditto		11
Bridges as before		20
Diversion of lines, &c., as before		2
Ferries		0·5
		258·5
Contingencies, 10 per cent		25·5
Assumed total for a draught 28 feet, exclusive of land		284

55. In estimating the outlay on works situated to a great extent in or near Calcutta, th cost of the land becomes an important item. The dock and appurtenances will probably occupy about 120 acres in a position where property is already of considerable value. About 800 acres will be required for the canal and slopes, and of this the cut to the Hooghly and a portion of the Calcutta end of the canal also pass through comparatively valuable property. Should it be intended to deposit any considerable portion of the spoil from the canal on the banks, it will be necessary, allowing for a safe berme, to take up about 4,000 acres. We fail to see any suitable place of deposit for the spoil from the dock and the Hooghly cut, without carrying it some distance, as, for instance, to the Salt Water Lakes.

The value of the land which would have to be taken up for the canal and dock, exclusive of any extra space for spoil-banks, we estimate at not less than 45 lakhs, bringing up the assumed total cost of the whole scheme to 329 lakhs.

56. With respect to the advantages of the present "warehouses, water supply, gas, and drainage," there can be no doubt that its proximity to a supply of good *water* gives this scheme an advantage over that at Diamond Harbour, the estimates for which are charged with 5½ lakhs for this item alone; but we attach little importance to the other points alluded to. The existing *warehouses* could be of little use to a dock two or three miles away, except at a considerable cost for transport. *Gas* would probably not be required at Diamond Harbour, as it is intended that the dock should be lighted by electricity as is now done at the Albert Dock on the Thames. And with respect to the *drainage*, seeing that the existing city drainage will necessarily be interfered with and have to be diverted more or less in carrying out the Mutlah scheme, it is probable that under this head the Diamond Harbour scheme will come out best.

57. Apart from the cost of Mr. Bruce's scheme, there are local and other objections which we think should have some weight—

(1) The removal of the Hooghly Bridge from its present site. Although on the completion of the East Indian Railway Bridge the purely railway traffic will be almost eliminated, the communities situated on the two sides of the river would be greatly inconvenienced if the present means of communication should be interfered with. This is altogether contrary to the general tendency at the present time, which is for river-side towns to afford every facility for rapid communication between the two banks of the river, and to bring them into the closest relationship.

(2) The partial severance of the roads and railways towards the north of the city, at present its most important outlet.

(3) Our colleague, Mr. Levinge, is of opinion that the channels of the Mutlah will deteriorate, when the Salt Lakes, which at present encourage the tidal flow, are reclaimed—a work which is now in contemplation, and must are long be carried out.

(4) As a minor matter, very great difficulty was experienced in closing a bend of the Pialee River cut off by the construction of the Calcutta and South-Eastern Railway bridge.

We believe that some of these objections might be overcome by fixing the site of the proposed Hooghly entrance at Garden Reach instead of at Chitpore, and the professional members of the Committee are of opinion that any ship canal to the Mutlah should be at a high level as suggested by Mr. Déjoux, and be filled with water from the Hooghly only, pumped as required from suitable settling tanks.

58. We now proceed to apply the facts, opinions, and calculations embodied in the foregoing paragraphs to the consideration of the specific questions on which we have been directed to report, and we think that this will most conveniently be done under the three following heads:—

1. Whether it is desirable that wet docks should be constructed in the Hooghly.
2. Whether Diamond Harbour is the best locality for such docks.
3. Whether docks at Diamond Harbour would be financially successful.

59. We have shown that the want of improved accommodation in the port of Calcutta has been the subject of discussion for upwards of fifty years; that the trade of the port has been increasing rapidly especially, of late years, since the opening of the Suez Canal; that the total tonnage of sailing vessels visiting the port remains much the same, whilst that of steam-vessels has increased considerably, and that the tendency is to build both ships and steamers of a larger size, the navigation of which in such a river as the Hooghly is more hazardous, and the loss of which involves the loss of much capital; that the navigation of the Hooghly and the detention of vessels in the open river while in port present dangers of a very appreciable kind, the avoidance of which is much to be desired; that the improvements effected by the Port Trust since its creation in 1870 have to a considerable extent met the demands of the growing trade up to the present time; that there is not room within the present limits of the port for much further expansion of those improvements, and that it may be anticipated with certainty that when the railway bridge at Hooghly is completed, and the railway systems of Bengal which are now in progress are further developed, the need for improved and extended accommodation in the port will become most urgent.

60. On the whole, therefore, we are of opinion that the first question may safely be answered in the affirmative. We pass to the second question, whether Diamond Harbour is the best situation for the docks.

61. Docks at Diamond Harbour would have three principal advantages: they would enable vessels to escape the intricate and dangerous navigation of the upper reaches; they would effect a saving of time, coal, pilotage, and towage, the money value of which alone would be sufficient to cover the dues payable for the use of the docks; and they could be constructed and maintained at much less cost than docks constructed at Calcutta. These advantages are so important that we think it necessary to dwell upon them.

62. If docks were constructed at Calcutta with an approach only from the Hooghly, as at present, it would be found (1) that the dangers of the navigation of the river would remain as formidable as ever; (2) that there would be less saving to compensate for the cost of using the docks; (3) that the cost of constructing the docks would be very largely increased by the higher price of the land, and by the much more expensive approaches by rail or road leading through populated suburbs, and therefore requiring numerous expensive crossings; (4) that the dues payable for the use of the docks would consequently be much higher; and (5) that their use would be a tax upon trade to a certain extent. If, on the other hand, the dangers of the Hooghly be considered sufficiently formidable to warrant their avoidance by means of the project for a ship canal to the Mutlah, all the disadvantages just enumerated, not even excepting the first, would be intensified; for it is not too much to assume that if, to use Mr. Bruce's expression, we have a second string to our bow, and the approach to the port is effected

by two diffierent channels, each of which will require its staff of pilots and tugs, its buoys and lights, the revenue available to maintain the efficiency of these will be spread over a much larger field, and therefore produce less satisfactory results. It is not the object of the Diamond Harbour scheme, nor is it claimed for any scheme that has been brought to our notice, that it should monopolise the trade of the port. The object is merely to supplement the existing conveniences and appliances of the port by providing docks which some of the shipping will find it convenient to use. It appears to us that this object will be best secured by placing the docks on the Hooghly, but at some point sufficiently low down the river to make the shortening of the voyage a tangible saving. In this way the same pilots, the same tugs, the same lightships, the same buoys, and the same river administration will continue to serve the whole of the shipping. But a scheme like the ship canal to the Mutlah can hardly be considered as merely supplementing the facilities of the port. To be successful financially it must become the port itself, to the exclusion of the Hooghly and everything belonging to it. It must have a monopoly of the trade, and on these terms we think its success could not be secured, and that, if secured, it would ruin the existing property of the Port Trust. This is a risk that is entirely avoided by the Diamond Harbour scheme.

63. On the other hand, our enquiries have shown us the existence of a strong, though not universal, feeling among the mercantile community that the transfer of a part of the business of the port to Diamond Harbour, or to any similar locality, would be attended with much inconvenience and expense. It would be necessary, it is urged, to keep up double establishments and to rent a double set of warehouses: matters of improtance will either have to be settled by subordinates, who will be unfit to deal with them, or will have to be delayed for the decision of a principal, who will be forty or fifty miles away. The value of the property of the Port Commissioners and of the owners of godowns in Calcutta will be seriously depreciated. The example of Port Canning is sufficient to show the danger of attempting to divert trade into new channels.

64. While we are not insensible to the force of these arguments, we are not prepared to accept them as conclusive objections to the scheme of constructing new docks. The course of business will accommodate itself in Calcutta, as it has done elsewhere, to the modified conditions which circumstances may render necessary. How it will probably do so we have already indicated in paragraph 50. We are not aware that the London merchants find any obstruction to their business in the fact that their vessels load and unload in docks at Blackwall or North Woolwich,[1] although almost all imports of produce, such as tea, &c., have to be examined on being landed by clerks or other professional examiners. We do not imagine that double establishments will be required, or that anything more will be necessary than the occasional deputation of a clerk on a railway journey of one or two hours. There is not, in our opinion, the smallest ground for apprehending that the establishment of the docks will have an injurious effect on the value of the property of the Port Commissioners, or of private owners of warehouses. We see nothing extravagant in the supposition that, at the end of another decade of years, the tonnage of the Hooghly may be double what it is at present. There will be ample work for all to do, and the new docks will merely provide an outlet for traffic which would otherwise be turned away from Calcutta for want of space. The failure of Port Canning merely shows that trade will not move into new channels without sufficient inducement to do so. It affords no argument against the success of a scheme which offers substantial advantages.

65. The location of the railway terminus at Diamond Harbour indicates that place as the natural position for the docks. But independently of this consideration, there is much to recommend the locality for the purpose. A dock much higher up the river would not save vessels from the dangerous part of the navigation: a dock much lower down would be too far from Calcutta to be convenient. Off Diamond Harbour there is good anchorage and sufficient space for about 30 vessels to moor without interfering with the fair-way for navigation. A part of the land which would be required for the docks is already the property of Government, and the remainder could be acquired at comparatively little cost. Finally, Diamond Harbour is already a recognised place of call for ships, especially on the outward voyage.

66. At the same time there are considerations on the other side which should not be overlooked. Diamond Harbour is believed to be unhealthy: the supply of drinking-water is bad; the subsoil, although perhaps not worse than in other parts of the delta of the Ganges, does not readily admit of the excavation of docks; the tides are at times so strong that vessels might sometimes have to wait until comparatively slack water before entering the dock, and there is

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[1] Docks projected still further down at Daggenham and at Purfleet (opposite Gravesend).

the serious objection that the entrance to the docks would be on a lee shore during the south-west monsoon.

67. We can hardly hope to find a locality free from all drawbacks, and we are not disposed to think that these objections need interfere with the selection of Diamond Harbour as the site for the docks. The alleged unhealthiness of the place will probably disappear when the ground is drained and occupied. A supply of good drinking-water can be secured, partly by digging tanks for rain-water, and partly by laying a pipe from Calcutta, for which provision has been made in our estimate. The unfavourable character of the subsoil (supposing this to be borne out by further experiment) will add somewhat to the cost of the dock, but will not affect its stability. The tides are not stronger at Diamond Harbour than elsewhere in the river, and it may fairly be said that all the foregoing objections would probably apply as forcibly to any other place which might be selected for the docks as they would to the locality which we recommend. The difficulty about the lee shore in the monsoon is of a different kind, and it has been strongly pressed upon us by gentlemen who have had many years' experience of the Hooghly. We desire, however, to invite attention to the following remarks recorded by our colleague Mr. Wawn:—

> "Since the last meeting of the Committee I have enquired more particularly into the reasons urged against the 'lee shore,' and I am satisfied that, whilst some of the local nautical gentleman appear to see no difficulty, others have, unintentionally, exaggerated the supposed dangers during the monsoon. Men who have spent the greater part of their lives in India have had few opportunities of observing the working of large wet docks, and naturally revert to *graving* docks as the nearest example. Captain Taylor, I. N., in his letter dated Calcutta, the 8th March, suggests a Committee 'including practical men, who have docked vessels either *here* or at Bombay Prince's Dock,' and other gentlemen, whom I have since consulted, speak in similar terms. In arriving at a decision on the subject, the Commitee should bear in mind that there is little analogy between a light vessel (with comparatively slight hold of the water, and presenting a great surface to the wind) being slowly warped into a graving dock very little larger than herself, and the same vessel steaming or being towed through a wide entrance into a large wet dock. In coming out of dock the conditions are still more favourable. I have no hesitation in saying that Diamond Harbour is not the place which I should choose for the entrance to a *graving* dock."

We are inclined to believe that the apprehensions which have been expressed are in some measure due to a want of practical acquaintance with the working of wet docks. Mr. Wawn has reminded us that, in former days, Diamond Harbour was the recognized port of Calcutta, large vessels seldom coming higher up the river; and he has also brought to our notice that at Sunderland the existence of a lee shore is not (unless under exceptional conditions of weather) found to be an obstacle to the docking and undocking of ships. It would, we think, be advisable that careful observations of the weather at Diamond Harbour should be made during the approaching monsoon, but we do not consider that the fact that the dock entrance will be on a lee shore need prevent the provisional acceptance of the locality as the site of the docks.

68. If it should be found that these objections are valid as against the precise spot chosen for the docks, we are nevertheless of opinion that the scheme should be adhered to, and some other neighbouring spot free from these objections should be chosen. On this point we should draw attention to our colleague Mr. Wawn's letter at page V of the appendix, pointing out the advantages of a site near Roychuck, 4½ miles higher up the river than Diamond Harbour Creek. He suggests that if this site should be found preferable, a very profitable river-side railway could be made to it, and connected to the existing Diamond Harbour railway, thus affording a double means of access to the docks. The profits of these railways would, it is expected, add materially to the financial success of the docks.

69. With regard to the third question, whether docks at Diamond Harbour would be financially successful, we beg to refer to the figures given in paragraph 41 of this report. The calculation there made appears to justify the conclusion that, if the docks can be constructed and maintained at a cost representing an annual expenditure of seven and a half lakhs of rupees, the outlay would be recouped by the receipts from 468 vessels, at an average of R1,600 each. The figures also show that, at this rate of payment, which is taken as equivalent to a charge of 1½ annas per register ton, there would be a considerable saving as compared with the present port charges, so as to afford a substantial inducement to vessels to avail themselves of the accommodation provided by the docks. We therefore think that there can be no doubt of the financial success of the undertaking, unless it can be shown either (1) that the docks would cost more than the estimated sum, or (2) that they would not be used by so many as 468 vessels, or (3) that the saving to each vessel by the use of the docks would be less than our calculation shows it to be. On each of these points we desire to submit some further remarks for the consideration of Government.

70. We have assumed that the outlay upon the docks will not exceed seven and a half lakhs of rupees per annum. It will be observed that we have not taken into account two items—the cost of acquiring the land, and the accumulated interest during the period of construction. We have no data for estimating the former, and the latter will depend upon the activity with which the work of construction may be prosecuted. But the cost will not in either case be large, and our estimates have been framed upon so liberal a scale that we do not anticipate that these items will require any material addition to be made to the total.

71. We have calculated that the cost of the docks will be covered by 468 vessels at an average payment of R1,600 each. In the year 1880-81 we find that 506 steamers and 478 sailing vessels arrived at Calcutta, against 412 steamers and 454 sailing vessels in the previous year. We have already remarked that we anticipate a large increase in the shipping of the port, and we expect that this increase will be stimulated by the recent reduction of the port dues to 1 anna per ton. But it will be seen that even if the number of vessels remained stationary, and only one-half of them used the docks, the number which we have assumed to be necessary would be more than attained. We think it probable that sailing vessels in particular will largely avail themselves of the advantages of the docks, as the benefits in their case are comparatively greater than in the case of steamers. It would not, perhaps, be an extravagant supposition to conjecture that by the time the docks are completed the number of sailing vessels alone which would enter them would be sufficient to furnish the receipts which we have assumed to be required. While, owing to its proximity to the Suez Canal, Bombay has a great advantage over Calcutta in the matter of steamer freights, the rates of freight between Calcutta and Bombay and England by sailing ships are much the same. Ship freights from England, however, are generally considerably lower than steamer freights and any facilities tending to cheapen the port and give greater facilities to ships must therefore help to neutralise the geographical advantages possessed by Bombay.

72. The saving to vessels by the use of the docks would probably (and especially in the case of sailing vessels) exceed the estimate which we have given. We have allowed R1,200 for towage up and down between the Sandheads and Diamond Harbour; but it is probable that many sailing vessels would dispense with the aid of steam at the Sandheads, and would only incur the charge for towage into and out of the docks and down to sea. On the other hand, it will be seen that we have not allowed for the railway charges between Diamond Harbour and Calcutta. It is difficult to estimate these, as they will probably not affect cargo (either export or import) which may merely be sent through Calcutta without being warehoused there. For example, the railway charge from Cawnpore to Diamond Harbour, or from Diamond Harbour to Cawnpore, may be expected to be the same as between Cawnpore and Calcutta. For goods warehoused in Calcutta, the railway charge between Calcutta and Diamond Harbour may be estimated at about one rupee per ton. We have retained the port hospital dues, as it will be necessary to make provision at Diamond Harbour for the treatment of sick seamen, and it is reasonable that the shipping should pay for this charge.

73. The design and size of the docks are discussed in the letter of our colleague Mr. Wawn which is printed at pages i to iv of the appendix to this report. That letter and the drawings which accompany it give a complete description of the design, and we need not attempt any further description of it in this place. We agree with our colleague in thinking that the site marked F is preferable to the others, and that the dimensions of the docks should be those which he has recommended for adoption. It will be seen that the design provides effectual protection against a storm-wave, and that there will be sufficient space within the enclosure for warehouses and other necessary buildings. Provision is also made for a supply of drinking water and for drainage.

74. In addition to the cost of the dock itself, it will be necessary to provide for the construction of godowns, &c., from which a separate and remunerative revenue will be collected.

75. To furnish the whole dock we estimate the cost at—

	R
Godowns, 120 feet wide, on each side of the dock (R2-8 per foot) .	24,00,000
Say 5 miles of rails and sidings	1,72,500
Say 40 steam or hydraulic cranes	2,80,000
Total . .	28,52,500

It will be advisable to erect only a portion of these at first, and the remainder from time to time, in answer to the requirements of the traffic.

76. It will also be advisable to acquire and reserve the site of the docks as indicated by plan F, together with a certain portion of the river frontage, and to let the ground out only on short leases. If appropriated to railway purposes, no permanent structures should be built thereon. We further recommend that steps should be taken for the extension of the boat canal to Diamond Harbour.

(Sd.) H. J. Reynolds.
(Sd.) H. C. Levinge.
(Sd.) S. T. Trevor.
(Sd.) Bradford Leslie.

Subject to reservations in my memorandum of dissent.

(Sd.) J. J. J. Keswick.

Subject to material reservations, as expressed in my "dissent."

(Sd.) G. H. Morrison.
(Sd.) Charles Wawn.

Dissent.

I regret to have to dissent from some of the views of my colleagues expressed in the report.

Paragraph 59.

1st.—I do not consider that there is not room within the limits of the port for much further expansion of improvements, but agree with Mr. W. D. Bruce (see page 144) that the present accommodation can be considerably increased. My enquiries lead me to believe that it is possible for the Port Commissioners to acquire land on both sides of the river from Garden Reach downward sufficient to double the accommodation of the port and provide sufficient warehouse and jetty room.

Paragraphs 62-63.

2nd.—If docks were to be constructed at Diamond Harbour, and to prove as economical and attractive as indicated in the report, I am convinced that some of my colleagues would find that they had made a mistake in thinking that in favouring the Diamond Harbour scheme they had "entirely avoided" depreciating the value of the existing property of the Port Trust. It is claimed in paragraph 64 that the new docks will merely provide an outlet for traffic, which would otherwise "be turned away from Calcutta for want of space," but I have no hesitation in saying that Diamond Harbour would fare very badly if it were wholly dependent for its income on vessels which could not find accommodation in Calcutta. It can only be a success if the time and charges which vessels will save by going there make it more profitable for them to use its docks than to proceed to Calcutta, and if more profitable to the extent of the figures shown, then Calcutta will only get the traffic "turned away from" Diamond Harbour "for want of space." If docks at Diamond Harbour give the advantages indicated in the report, I take it that the accommodation will not remain stationary, but that the building of docks will be proceeded with to meet the demand; and to expect shipowners to continue to send their vessels to Calcutta, and to calculate at the same time that by stopping at Diamond Harbour they can save R500 to R2,500 per voyage, is to expect shipowners either not to believe in such calculations, or to have no eye to economy, whereas any one who has had experience of them knows that they recognise as quickly as their neighbours that a penny saved is a penny gained. We cannot expect that the ships which now come to the port of Calcutta will always continue to come to it, and that the additional ones which the increased trade will attract will be sheltered exclusively in Diamond Harbour. If the new port is to be successful, it must be used by about 468 vessels at least; and if it hold out sufficient inducement to attract that number, whether from increased trade or from the present trade of Calcutta, as exampled in paragraph 71, it must, in my opinion, do much to lower the value of property in this city. Experience alone will show whether shippers from home or other outports will pay as high freights and ship as readily to Diamond Harbour as to Calcutta, or whether exporters will pay as high freights and ship as readily from Diamond Harbour as from Calcutta. The consensus of opinion of merchants is against Diamond Harbour, and the calculation for shipowners, if vessels earn higher freight by coming to Calcutta, will be whether the extra freight earned is a sufficient set-off against the saving the ship would have made by stopping at Diamond Harbour. It is possible that for some cargoes, both inwards and outwards, Diamond Harbour

Paragraph 69.

will have the pull, while for others Calcutta will be preferred; but I think one of two things will happen—Diamond Harbour will be a failure, or Calcutta will be much injured. If the Port Commissioners, after the adoption of the Diamond Harbour scheme, if adopted, wish to raise another loan, I think they will probably find the views of the public unmistakeably expressed. That the docks, if constructed at Diamond Harbour, and the railway to them, should be under one administration, I grant, but would deprecate permitting any company to construct and work docks at Diamond Harbour. If docks are to be constructed there, or anywhere else, to serve Calcutta, they and the present Port property must, in my opinion, be under one administration and worked together for the general good, so that in considering either the Diamond Harbour scheme or Mr. Bruce's scheme, the reduction of income in connection with the existing property of the Port Trust must be considered along with the probable income from the new scheme.

Paragraph 64.

3. I do not think that in weighing the objections to the Diamond Harbour scheme, which Calcutta merchants have advanced on account of the inconvenience and expense of doing business at such a distance from Calcutta, the example of London merchants sending their clerks or professional examiners to vessels loading or unloading in docks at Blackwall or North Woolwich, as put forward in the report, is a happy one. Trains, steamers, and omnibuses run between London and these docks, distant 5 and 8¾ miles respectively, every few minutes, and it is easier and quicker to get to them from the City of London than it is to get to Garden Reach from the City of Calcutta. So many passengers travel that it pays to start trains often, and the speed is greater than here. It is calculated that Diamond Harbour will be reached by a railway journey of one to two hours; but I think we may safely say that it will rarely be accomplished under two hours or more, as we shall probably have mixed trains, partly goods and partly passengers, and many stoppages, so that one might get from London to Brighton and back by the fast expresses which run so often in the time that it would take to get from Calcutta to Diamond Harbour, while Portsmouth, 75 miles from London, and Southampton, 77, can both be reached quicker and oftener per day than we are ever likely to reach Diamond Harbour if trains travel here as slowly as usual. The P. & O. Company have found it profitable to give up Southampton, and run their vessels round a long coast to London. North Woolwich and Blackwall are actually parts of London, and docks were only constructed even at these short distances from the city because there was no room nearer. Gravesend, near which new docks are now to be made, is only 22 miles from London, and you can get there almost as quickly as from Calcutta to Barrackpore.

4. The memorandum furnished by Mr. Bradford Leslie, and quoted in the report, shows an enormous increase in the railway tonnage in the past five years, and indicates, with good reason, an even greater increase in the next five; but an entire change will have to take place in the system of doing business before whole cargoes of grain, seeds, and other produce are bought up-country, assorted there by the shippers, and despatched right to the ship to be transferred at once from the railway wagons to the ship's hold. Mr. Morrison has entered into details as to how business is done at present, and it is unnecessary for me to do so; but I would call prominent attention to the fact that Messrs. Ralli Brothers, who are the largest exporters from this country, state emphatically that "the proposed scheme, far from affording any advantage, would tend to cause many inconveniences both to importers and shippers." They state that at present, of the seeds and wheat exported, 40 per cent. are not warehoused; but ask it to be noted that whatever quantity is exported direct from the Howrah railway station is subject to examination by the shippers in the presence of the sellers in order to ascertain condition, quality, weight, and refraction of the different parcels before shipment, and that such operation could not be effected satisfactorily at Diamond Harbour unless at the great expense of each shipper and seller keeping a separate establishment there.

Paragraph 47.

As stated by Mr. Morrison, "our exports are the produce of the soil, and scarcely two lots offered to the merchant are quite alike;" and all who have had experience in shipping produce from this country—a country for which a Cotton Frauds Act was drafted—know that vigilance is required before produce is shipped. If Diamond Harbour be made a shipping port, and have the success expected, the system of business pursued in this country cannot fail to make it a great emporium of trade, as well as a place of export; and I doubt if the saving in municipal taxes, calculated on, will be realised, while probably it will be found that the Calcutta Municipality will object to supply the filtered water, for the conveyance of which allowance is made in the estimate.

5. In conclusion, I have to say that I consider the dangers of the river above Diamond Harbour are somewhat magnified, while those below are not sufficiently allowed for. Of 26 wrecks in the river in the last 20 years, we are told that only 10 have occurred above, while 16 have taken place below, and professional opinions have been expressed that if ever the river

closes to navigation, the closing is more likely to occur below than above Diamond Harbour. I would advocate, then, that before proceeding further with reference to Diamond Harbour, steps be taken to ascertain what further accommodation can really be provided for shipping by the erection of jetties and warehouses within the limits of the port of Calcutta, and what further land can be acquired on both sides of the river at Garden Reach and below it, suitable for jetties and wet docks, with its probable cost. That wet docks can be constructed at Diamond Harbour, and that they may, by their proximity to the sea, save the time of vessels as well as much expense in towage and pilotage, I believe; but I ask it to be considered whether, if a saving per vessel per voyage of between R500 and R2,500 is to effected by stopping at Diamond Harbour, shipowners will sacrifice it and go to Calcutta. If they will not, how is Calcutta to remain uninjured? and if, on the other hand, such saving cannot be effected by stopping at Diamond Harbour, where will be the inducement to vessels to stop there, and what will warrant an outlay of a crore and a half of rupees in that new place?

CALCUTTA, J. J. J. KESWICK.
The 3rd May 1882.

DISSENT.

I agree generally with Mr. Keswick in his conclusion, but I doubt how far the Port; Commissioners of Calcutta could efficiently control docks 45 miles away; and I doubt also whether, having regard to the nature of our river, it would be prudent to spend large sums of money on docks or other such appliances having access to the sea only through the Hooghly.

I think it would become prudent to do this only when it had been decided to excavate a ship canal to the Mutlah, either at once or hereafter, as necessity might appear.

It follows that I am opposed to the construction of docks at Diamond Harbour, and particularly I am so for the following reasons:—

(1) Because we cannot confidently say that the channels between Diamond Harbour and the sea will admit of the free passage of vessels of the latest type, much less of the probable type of the future.

(2) Because safe entrance into, and egress from, the docks will, during a sensible portion of the year, be questionable.

(3) Because docks at Diamond Harbour, if successful, would gravely prejudice Calcutta as a centre of trade, and probably ultimately destroy it as a port.

(4) Because it is probable that the interests of Bengal at large can be effectually provided for, not only without impoverishing, but by means which must greatly enrich, its capital.

I have fully dealt with these points in a letter to the President of the Committee, printed at pages 98 to 103.

I dissent entirely from paragraph 62. If the Mutlah scheme were found feasible, " (1) " the dangers of this river, "the Hooghly," would cease altogether to be formidable, because they would be avoided; " (2) " there would be, on everything landed and shipped, a saving at least equal to that which could be effected at Diamond Harbour; and on much of our imports and exports a greater saving, *viz.*, greater by the charge for railway transit between Calcutta and Diamond Harbour, and by the costs and losses attendant upon extra handling of goods; " (5)" the "tax on trade," which the Mutlah scheme would impose, would be simply the price paid for a much larger benefit. The docks of the ship canal would be in the port and part of the port, and the " ruin " they might inflict on the existing property of the Trust (so far as it did not prove imaginary) would be the " ruin " which a capitalist inflicts on his old plant when he introduces into his own concern and for his own profit the most improved of modern machinery. I think the jetties would continue to be used; but if not, the dock dues would amply maintain the Commissioners' income and their credit. How it can be said that stopping vessels 45 miles from Calcutta avoids the risk of ruining the property of the Calcutta Port Trust I am unable to understand!

Paragraph 57.—I feel much diffidence in approaching the objections to Mr. Bruce's scheme which have been raised by our professional colleagues; but I would say—

(1) That the cost of the ship canal system must be considered in the light of the advantages it will yield, and the general depreciation of property which it will obviate I think, too, that no estimate of cost should be accepted until Mr. Duff Bruce had had an opportunity of explaining his views in greater detail, nor until a more deliberate estimate had been made of the cost of acquiring the necessary land.

(2) That the removal of the Hooghly Bridge is no necessary part of the scheme.

(3) That the severance of the important outlets to the north of the city could obviously be avoided by cutting the canal from a point towards the southern end of the port.

(4) That if draining the Salt Lakes would spoil the Mutlah, it might be better to leave the Salt Lakes undrained.

Paragraph 50.—The scheme adverted to here, and which in paragraph 49 is relied upon as destined to effect great savings in cost of transit,—*viz.*, to construct in proximity to the circular canal, and in communication with all the railways, a monster depôt, or range of godowns, in which facilities should be provided for storing, examining, cleaning, sorting, packing, and marking,—would, no doubt, prove of great benefit to Calcutta. But I do not think that any such arrangements would ultimately prevent our trade from leaving us; and is they failed to do this, much of the cost of the Calcutta depôt would be wasted. Moreover, as compared with the Mutlah canal scheme, the Hulsee Bagan godowns must necessarily leave upon trade a removable burden of at least R1 per ton,—*viz.*, the cost of carriage to Diamond Harbour; and this calculated upon the commerce of our port, would more than cover the difference between the annual income necessary to give a satisfactory return upon the capital required for the Diamond Harbour docks and the revenue necessary to give a like return upon the cost of completely carrying out the Mutlah project.

G. H. MORRISON.

From CHARLES WAWN, Esq., M. INST. C.E., to the President of the Committee on Docks at Diamond Harbour,—No. 1, dated Calcutta, the 4th March 1882.

As a preliminary to the preparation of the general report of the Committee on Docks at Diamond Harbour, of which I have the honour to be a member, it appears to me desirable that I should recapitulate, in a letter to yourself, the various suggestions which I as the Special Engineer have at different times made to the Committee, and at the same time explain generally the special features of the designs which I have prepared.

GENERAL SCHEME OF THE DOCKS.

The general arrangement as shown on the drawings is based on the supposition that although the dock as constructed at first may be comparatively small, it will shortly be found necessary to enlarge it, and, as the trade increases, eventually to supplement it by another. The space proposed to be enclosed provides for considerable extension of dock area and also for the construction of graving docks, which are certain sooner or later to follow. The locks and entrances have also been designed with these probabilities in view, although at the same time I consider that duplicate entrances and gates are almost indispensable in any dock intended for first class shipping—the one affording a means of carrying on the traffic during repairs and the other ensuring the safety of the shipping in the event of an accident preventing th, closing of one of the gates.

I am decidedly of opinion that any dock constructed on the Hooghly would be a failure is it did not afford protection, not only from the ordinary dangers incidental to a tidal river, but also from the much greater, though less frequent, effects of a cyclone wave. To meet this necessity, I propose to enclose the dock and appurtenances with an embankment or "bund" formed of the spoil from the excavation, and continued across the lock entrances where there must necessarily be a break, by gates of the same height opening outwards like those of a graving dock.

The most exact information which I have been able to obtain as to the height of the 1864 inundation is from a mark on one of the buildings at Diamond Harbour, which shows the maximum height of the water to have been about 13 feet above the general level of the ground. My suggestion is that the dock bund should be eight feet higher than this, and that for strength and general utility it should be not less than 30 feet wide at the top with slopes of at least 3 to 1. Such an embankment, 21 feet above high tide of ordinary springs, may eventually come to be of use to carry a high level railway, should coals ever be shipped in the dock, or huts may be built on it as sleeping-places for the sailors during the hot weather.

In view of the increasing length of the vessels for which accommodation is to be provided, it is a matter of importance that the course into the dock should be as easy and as nearly straight as possible. Much valuable time at the best part of the tide is lost in warping even a short vessel into an awkwardly constructed dock. Further, where it is practicable to make dock-walls straight, there is a certain economy in doing so; vessels of different lengths are berthed without loss of quay space, and moveable steam and hydraulic cranes traverse the whole length of the quay without interruption.

It is desirable that an outer or half-tide basin should form part of any dock establishment at Diamond Harbour, where at certain seasons of the year the water begins to fall rapidly immediately after high tide. The basin as designed is of sufficient width to afford also a turning place for vessels too long to be turned in the dock.

As the district around Diamond Harbour has (or had) the reputation of being unhealthy during the rains, the surplus material from the excavation may, with advantage, be applied to raise a portion of the land near the river to about the level of the dock bund, affording a secure and comparatively healthy site for dwelling-houses, Custom House, &c., and at the same time a place of refuge in case of a cyclone flood.

Notwithstanding the extension of the railway system, and the increased proportion of goods carried by rail, there will always remain a considerable trade, both in distributing and collecting, to be carried on in the rivers by the native craft. If the Committee should recommend the construction of docks at Diamond Harbour, I think they ought to consider also by what means these small vessels are to be saved the dangerous passage between that place and Calcutta. I would suggest, for consideration, that a shallow canal, from Tolly's Nullah to Diamond Harbour Creek, could be made by the side of the existing road at comparatively little cost, a considerable portion of the suggested site having been already excavated to form the road embankment. A siding and small landing jetty at the point where the railway to Diamond Harbour crosses Tolly's Nullah would also be of service.

SITE.

The small-scale drawings which accompany this letter show the different sites which on various grounds suggested themselves after my first visit to Diamond Harbour, and after carefully weighing the advantages of each, I am of opinion that that marked F is on the whole the most suitable. The principal reasons which led me to this conclusion, and the comparative merits and demerits of the various sites, may be briefly stated.

Sites A, B, and C utilised the creek either wholly or in part, with the saving of about *one-third* of the total excavation (and that the cheapest part) near the top in the case of A, and of about *one-fourth* in B and C. Owing to the bends in the creek, however, a dock so constructed, particularly in the case of A, would be far from satisfactory, and in any case we should have the cost of providing another outlet for the drainage water now passing through the creek.

Beyond the saving in excavation, which in this instance does not exceed three or four lakhs of rupees, there would be nothing gained in dockizing the creek. It would be altogether different if, as is sometimes the case, it were already used as a commercial harbour and provided with wharves, godowns, &c., and required only a greater depth of water at low tide to convert into a first-class dock.

In designs A and B I should be apprehensive also of an unequal settlement of the masonry of the locks.

Against site D, which utilises the creek as a tidal basin, and which would otherwise have been very suitable, is the cost of widening and deepening the channel in the creek involving the dredging to the amount of about 300,000 square yards; the cost of a bridge about 300 feet long, and the danger of the creek deviating from its present course to an extent sufficient to necessitate a considerable annual outlay in keeping open the approach. That the creek is liable to alterations of this kind is, I think, shewn by an examination of the old bunds.

The site shown on drawing E suggested itself as a means of utilising the railway and both the stations as designed without alteration. It is, however, open to objection in the want of a straight course through the basin and in the comparatively narrow anchorage ground opposite the entrance.

Site F appears to possess the balance of advantages. The drainage of the country is not interfered with. The creek remains to be used for subsidiary purposes,—*i.e.*, as a tidal basin for the smaller craft, &c. The entrance through the basin is nearly straight, and the anchorage good. The current from the creek will assist the dock sluices in keeping the entrance free from deposits, and should the creek at any time materially alter its course, the dock entrance is near enough to the river to be easily kept open. The railway station would be in a position on the bund convenient for the dock entrance, for the ferry, and for boats landing passengers from vessels in the river.

A certain amount of erosion of the Hooghly bank at Diamond Harbour was to be expected, and on comparing the oldest survey which can be found (30th June 1858) with that made last year, it appears that the bank on the west side of the entrance to the creek has suffered considerably, the old post-office building, which was then standing at a little distance from the bank, being now a heap of ruins below high water-mark. On the east side of the creek entrance, however, on which it is proposed to construct the dock, the loss has been comparatively small—as nearly as can be measured on the drawings, about 10 feet altogether, or less than half a foot per annum. Even should this rate of progress show a tendency to increase, which is not unlikely, seeing that the protection of the opposite point has been to some extent reduced, many years must elapse, and probably other changes take place, before any question can arise as to the necessity for further protecting the dock works. The line of the river bank as it existed in 1858 is shown on drawing No. 1.

During the south-west monsoon the river bank at Diamond Harbour will be exposed to the full force of the wind, and present to a certain extent a lee shore. After consulting Mr. Yates, the Harbour Master, who has had many years' experience on the river as a pilot, it appeared to me that the difficulty would be sufficiently met by putting down buoys with screw moorings to check or steady the vessels whilst entering the locks during the monsoon months. Since that, however, Mr. Milner, another gentleman of experience as a pilot, says in his reply to the circular of the Committee that, being to leeward in the monsoon, "it is a most unsuitable place for docking vessels." This is a question for a seaman rather than for an engineer; and not having had the opportunity of seeing the river during the monsoon, I feel a difficulty about giving an opinion. I understand, however, that in the olden time the Indiamen received and discharged cargoes here—presumably during the whole year—and that it was to all intents and purposes the port of Calcutta. The South Dock at Sunderland is successfully worked under what appear to be much worse conditions, for it is entered directly from the German Ocean, and except when a continued gale from the east raises a sea which would make it dangerous to vessels in the dock for the gates to be opened, no difficulty is experienced in entering or leaving the dock. Altogether, it is a point demanding careful consideration and the best nautical opinion we can get. If it should be made clear that the situation is *really* so rough and exposed as to make it unsafe for a vessel to enter a dock, I think we may dismiss at the same time any idea of jetties and coal wharves, except on a small scale and as a temporary expedient to be used in fine weather only.

Foundations.

The trial wells and borings undertaken to ascertain the nature of the deposit at Diamond Harbour have been delayed through various causes, and I am only now in possession of any real information on the subject. The operations are not yet complete, but so far as they have gone, I regret to say that the favourable opinion entertained by several gentlemen of experience has not been altogether confirmed. The walls of the dock, and possibly those of the basin, may, I think, be got in dry, but the locks, and the passages from the basin to the dock, will have to be founded on brick walls, which should be carried to a depth sufficient to afford a support equal to two tons per square foot over the whole surface. Each well, after being filled with concrete, should be individually tested with this load; but the weight should in no case be applied until all the wells in the immediate vicinity have been sunk.

Details.

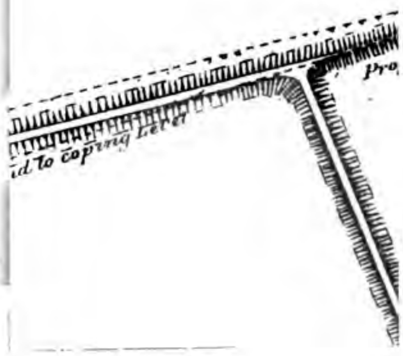
In anticipation of the report of the Committee being favourable to the construction of a dock, I have prepared, in addition to the small-scale drawings of the different sites, a series of drawings enumerated in the margin, showing generally the arrangement which I propose, and going to some extent into details of construction.

No. 1. Site of dock and sections.
„ 2. Locks and sections.
„ 3. Entrance to dock and sections of walls
Nos. 4, 5, 6. Gates.
No. 7. Diagram of tides.

"Datum," as in the case of the Diamond Harbour Railway, refers to *mean sea-level.*

Accompanying the drawings is a diagram showing the highest and lowest tide in each month from 1872 to 1880, as recorded by the self-acting tide gauge at Diamond Harbour, and on which I have marked (arbitrarily of course) "H.T. rains," "H.T. dry season springs," "H.T. neaps," and "L.T." Disregarding exceptional tides, these are, I believe

CKS



fair approximate levels, and are those to which I have worked in preparing the drawings. "Coping level" is placed at three feet above "H.T. raids," or two feet above the highest tide recorded by the gauge.

The bottom of the main dock is designed to be 23 feet below datum, giving a depth of 26 feet of water at H.T. neaps. The basin and locks are intended to be three feet deeper.

The dock, as constructed at first, is intended to be 4,000 feet long by 500 feet wide, the basin approximately 800 feet square, and the entrance locks respectively 560 feet long by 80 feet wide and 400 feet long by 60 feet wide.

The land for about 300 feet back from the walls is intended to be raised to the level of the coping. Provision must be made for draining the remainder, and this I think it will be safest to do by sluices into the basin, rather than through the bund.

It is intended that the excavation shall be got out, as far as possible, dry, in the usual way, and that the remainder be dredged to the requisite depth after the water is admitted to the dock.

I desire here to refer more particularly to certain details of construction, necessitated by the peculiar features to be dealt with: (1) the nature of the foundation; (2) the great variation in the level of high tide; and (3) the cyclone wave. The two former affect chiefly the height and width of the walls. It is desirable in all cases, and more particularly in dealing with a deposit like that of the Ganges delta, to distribute the weight as evenly as possible over the foundation. The walls, as shown on the drawings, have been designed with special reference to this requirement, the line of pressure passing approximately through the centre of the base, not only when the wall is standing alone, but by reason of the steps at the back which receive increments of weight nearly in proportion to the horizontal thrust; also when exposed to the whole pressure of the earth behind.

I may mention that in designing the wall I have not considered it safe to assume that the earth backing, saturated with water as it will be, would naturally stand at a more favourable slope than about 4 to 1. The top of the piling is intended to be embedded in the concrete of the wall, and not placed in the front as a mere toe, which would be easily thrust out of the perpendicular.

Should the progress of the work on a large scale show that there will be any real difficulty in keeping the excavation sufficiently dry to get in the concrete foundations for the dock and basin walls as designed, it will be necessary to carry them on wells, in which case I should prefer to adopt the triangular section lately used successfully in the construction of the Stobcross Dock at Glasgow, and which I have shown, with alternative sections of the walls, on drawing No. 3. I trust, however, that it will not be necessary to resort to wells, at least for the dock walls, which are only five feet lower than the foundation of the lock at Chitpore, where no great difficulty has been experienced.

In order that the storm gates when open may be no obstruction to the passage to and fro of the men attending on the vessels passing through the locks, it is intended, as shown on the drawings, that they be set back into the wall five feet further than the other gates, and that the break in the quay line be made good by a platform on the front of the gate. The gap at each end of the platform is intended to be bridged by a small moveable timber gangway, so constructed as either to be moved by the gate, or (if neglected) to form no impediment to the closing of the gate. The gangways should be such as will float in the event of their being accidentally thrown into the lock, lest by falling on the sill they should obstruct the closing of the gates. To ensure their being in working order, the storm gates should be closed at least once in every 24 hours. The sluice doors at this point must hold water both ways.

I have not shown on the drawings the hydraulic or other machinery for working the gates, sluices, or swing bridge, the details of which depend greatly on the manufacturers.

Fresh-water Supply.

I estimate that for some time to come it will be sufficient to provide good fresh water (in addition to what may be impounded in tanks during rain in the usual way) for an average of one passenger vessel and eight other large vessels per day, with an addition of 10 gallons per day for about 2,000 resident inhabitants. To bring this quantity from Calcutta will require, if supplied from a head of 40 feet, a pipe about 10 inches in diameter, which in case of accidents should deliver into a tank large enough to contain at least one week's supply. When the demand increases beyond what the 40-feet head will supply, the quantity of water delivered by the same pipe may be increased by pumping to a pressure equal to a head not exceeding 120 feet.

ESTIMATED COST.

Subjoined are the heads of my estimate, in which I have included the cost of eight hydraulic capstans for hauling vessels through the locks, &c.

From the tentative character which part of the work must necessarily assume, it is difficult to estimate with accuracy the cost of the well foundations.

It should be noted that the bund, storm-gates, and water-supply, although necessary in this particular case and included in the estimates, are additions beyond the requirements of an ordinary dock.

	Lakhs.
Dock	42
Basin	17
Passages between dock and basin, and gates	6
Locks and gates	24
Wing walls	½
Hydraulic machinery and pipes	4
Bollards	½
Coffer dam	2
Granite for quoins	2
Swing bridge	½
Fresh water-supply	5½
Well foundations, say	23
	127
Contingencies, say 10 per cent.	13
TOTAL	*140

The locks with their foundations are the most expensive part of the design. By reducing them to 200 feet long each, the total cost may be brought down to about 118 lakhs. I do not, however, think it would be desirable to do this, for, although there would still be duplicate gates and locks through which small vessels could be passed at low tide, the want of the larger lock would at times be greatly felt.

Pray bear in mind that this is to be considered merely as an *interim* report, and that both drawings and estimates have been prepared on the supposition that the borings, &c., now in progress, will show no more unfavourable results than those already completed.

BENGAL CLUB,
The 4th March 1882.

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* *The Committee have added 10 lakhs for establishment during construction.*

Memo.—By the Special Engineer,—dated Bengal Club, 3rd April 1882.

Since the last meeting of the Committee I have enquired more particularly into the reasons urged against the "lee shore," and I am satisfied that whilst some of the local nautical gentlemen appear to see no difficulty, others have, unintentionally, exaggerated the supposed dangers during the monsoon. Men who have spent the greater part of their lives in India have had few opportunities of observing the working of large wet docks, and naturally revert to *graving* docks as the nearest example. Captain Taylor, I.N., in his letter dated Calcutta, the 8th March, suggests a Committee "including practical men, who have docked vessels either *here* or at Bombay Prince's Dock," and other gentlemen, whom I have since consulted, speak in similar terms. In arriving at a decision on the subject, the Committee should bear in mind that there is little analogy between a light vessel (with comparatively slight hold of the water, and presenting a great surface to the wind) being slowly warped into a graving dock very little larger than herself, and the same vessel steaming or being towed through a wide entrance into a large wet dock. In coming out of dock the conditions are still more favourable. I have no hesitation in saying that Diamond Harbour is not the place which I should choose for the entrance to a *graving* dock.

There is one point which has not been brought out at all clearly in the replies to the questions of the Committee. Mr. Steel shewed that *time* would be saved in working cargo in dock rather than at jetties in the river, and in this he is corroborated by Mr. Morrison. But in addition to this there is a clear saving of *cost*, for the vessel being always practically at the same level with relation to the quay, gangways can be laid on to her decks and the greater part of certain descriptions of cargo lifted by her own steam cranes and wheeled or carried direct into godowns, or *vice versâ*.

From CHARLES WAWN, Esq., M. INST. C.E., Special Engineer, to the President of the Committee on Docks at Diamond Harbour,—No. 2, dated Calcutta, the 27th April 1882.

I beg to report to you, for the information of the Committee, that since my letter of the 4th March, three borings have been made on the site of the proposed dock on the south side of Diamond Harbour creek, each to a depth of 82 feet, and a brick well, now in process of sinking, has reached a depth of 25 feet. The positions of the borings and well are shown approximately on drawing No. 1. The results generally show a mixture of silt and sand in varying proportions. At the surface and towards the bottom of the borings the material has much the appearance of blue clay, whilst at the level of the bottom of the proposed dock wall (about 40 feet down) it contains a large preponderance of sand. In the first boring a good deal of water appeared to be present with the sand, and on visiting the works yesterday I found that the well at a distance of 120 feet from the boring had reached, at a depth of 25 feet, a stratum of watery sand, much the same apparently as that passed through by the boring. As seen through the better facilities afforded by the well, it appears at this point to be little better than a quicksand. In borings Nos. 2 and 3 the sand was not in the same semi-liquid condition as was noticed in No. 1, and it is probable that, when the excavation is opened out on a large scale and suitable pumping power and other appliances brought to bear, no great difficulty will be experienced from this source. At the same time, the condition of affairs disclosed by the borings and well, should it prove to be alike over any considerable portion of the area, introduces an element of uncertainty as to the cost of at least one part of the contemplated works.

I think it is desirable that some further observations should be made during the approaching monsoon season to determine whether the oft-repeated objection to the dock, on the ground of its exposure towards the south-west, be well grounded or not. I have already stated (appendix, page iv) that in my opinion the danger has been greatly over-estimated, chiefly from want of experience in the working of such docks, and in this I am confirmed to a great extent by letters from the nautical men printed in the appendix. This leads me to suggest that, if possible, any party deputed to make the observations should include three or four captains of merchant vessels, both sailing and steam, who have had general experience in different ports where wet docks are in operation; and that, as a matter of detail, the direction and width of the two proposed entrances should be at the time conspicuously indicated by poles, easily recognised from the anchorage ground.

As the matter stands at present, there are two objections of more or less weight to the site suggested for the dock at Diamond Harbour—the state of the foundation, and the fact of its being on a lee shore during the monsoon. It appears to me that the Committee would be quite within their powers in suggesting the examination of an alternative site, which though not actually at Diamond Harbour, is sufficiently near to be easily brought within reach of the railway.

A point about half way between Roychuck and Ramchunderpore, four and a half miles to the west of Diamond Harbour, whilst avoiding the James and Mary's and other dangers of the upper reaches, is less exposed during the monsoon, and appears to be generally well situated for the entrance to a dock. I would suggest that (1) any observations during the monsoon directed to Diamond Harbour should be extended also as far as Roychuck; (2) that a special survey of the surrounding district be made; and (3) that trial wells and borings be at once (before the rains) commenced on the site I have indicated on the accompanying plan. Should better results be obtained here than at Diamond Harbour,—*i.e.*, should the firmer material be found at a less depth,—I should recommend it as generally the more desirable site of the two. The anchorage ground is not so wide as that of Diamond Harbour, but it is not a generally recognised anchoring place for vessels proceeding up or down, and no ships, except those intending to enter the dock, would as a rule bring up here. The Diamond Harbour Railway would of course be extended to the dock, but in addition to this I would suggest the construction at an early date of a river-side line from the dock to Calcutta, taking in Fultah, Atcheepore, Budge-Budge, Akra, and other places of importance. Such a line, passing through a populous manufacturing and trading district, would probably pay well, independently of any traffic from the dock.

On the accompanying river survey plan I have shown approximately, subject to modification on the completion of the suggested survey, the site which appears to me to be the most suitable. The size of the dock, basin, locks, &c., and the details of locks, bund, storm-gates, &c., would be the same as at Diamond Harbour, and the boat canal suggested in my last could be as easily made to this point as to Diamond Harbour.

I ought to have mentioned in my former letter that the rates on which the estimates are founded were, after consulting several gentlemen of experience, fixed by me at an average of R16 per thousand cubic feet for excavation, including transport, with an addition of 25 per cent. for pumping, making R20 in all. The rate for ordinary brick-work was taken at R36, and for brick-work in cement at R50 per hundred cubic feet.

From G. H. MORRISON, Esq., to the HON'BLE H. J. REYNOLDS, C.S., President, Committee on Docks at Diamond Harbour,—dated Calcutta, the 24th April 1882.

As desired by you, I now beg leave to submit my views upon this question.

I yield to no member of the Committee in appreciation of the immense benefits that would result from docks well designed and well placed, but I do not think well of docks at Diamond Harbour—

(1) Because we cannot confidently say that the channels between Diamond Harbour and the sea will admit of the free passage of vessels of the latest type, much less of the probable type of the future.

(2) Because safe entrance into and egress from the docks will, during a sensible portion of the year, be questionable.

(3) Because successful docks at Diamond Harbour would gravely prejudice Calcutta as a centre of trade, and probably ultimately destroy it as a port.

(4) Because there is reason to think that the interests of Bengal at large can be effectually provided for, not only without impoverishing, but by means which must greatly enrich, its capital.

I will proceed to deal with these points *seriatim*.

I.—Access to the Sea.

In considering this point I imagine that we must keep in view the requirements of the largest vessels which can pass the Canal,—*viz.*, 26 feet draught; for if our river is closed to vessels which can visit other ports, we must be shut out from such cheapening of freights as developments in ship-building are calculated to effect.

The evidence before us is as follows:—

(*a*) Between Diamond Harbour and Saugor, since 1871, it has been necessary to change the route taken by vessels at least three times. After being in use for periods varying in length, each channel in turn has closed itself by throwing up a bar, and in none of the combined channels at any time has the depth of water been sufficient to allow a deep-laden ship to pass except towards the top of the flood.

(*b*) Saugor Roads have distinctly deteriorated, so that it is now difficult to find safe anchorage for large vessels.

(*c*) The outer channels from Saugor to the sea are changeable and dangerous. The main channel—Gaspar—has had 19 feet of water reduced since 1870, but is noticed to be shoaling and narrowing. In 1853, 1854, 1855, soundings gave only 12 to 15 feet reduced, and on a patch only 10½ feet. It has been shown that if the Gaspar were again to shoal to 16 feet, vessels drawing over 25 feet would be unable to pass during 71 days out of the first six months of the year, and vessels drawing over 26 feet would, during the same period, practically be excluded.

A glance at a good coloured chart of the Hooghly seems instructive. The "patchy," broken, and sinuous character of the deep-water channels is very remarkable. Not one continuous!

It has been said that we have managed to get ships in and out for a hundred years, why not therefore for another hundred? Yes; but not habitually such ships as are now being built. We are at the point which allows no margin for development; any shoaling of our approaches or any step in advance by ship-builders puts us out of the race.

It may be possible to improve our river, or at least to protect it from deterioration; but till satisfied that this is practicable, is it wise to spend two millions sterling on docks and warehouses, and to induce a large additional expenditure on railway works and other buildings, public and private; on water-works, sanitation, and all the needs of a township, which if anything at all, will be an important settlement?

II.—Safe entrance and egress at all times is doubtful.

The preponderance of nautical evidence is, that in the south-west monsoon it will be a work of difficulty and danger to dock, whilst it will not be practicable at that season to provide safe anchorage for more than a limited number of vessels waiting to dock.

But *to wait* is to frustrate the very *raison d'être* of the dock.

It is said that at Sunderland the existence of a lee shore is not an obstacle to docking and undocking, unless under exceptional conditions of weather; but before accepting this as conclusive, I submit that it would be desirable to know more about the Sunderland docks, and to ascertain whether such weather as prevails at Diamond Harbour during the south-west monsoon is or is not sufficiently "exceptional" to interfere with docking.

III.—Injury to Calcutta.

There is a notion that the docks will be, so to speak, an adjunct to, or suburb of, Calcutta. The London Docks are instanced as in point, and it is asked why a run by rail should in India separate interests which in London are identical in spite of people using a train.

The answer is that the two cases are about as diverse as can well be imagined.

In the first place, there is not to my knowledge any instance in the world of the two parts of one port being separated by a distance of 45 miles. To compare the aggregate of continuous townships, called London, with the snipe marshes between this place and Diamond Harbour, surely suggests nothing but a contrast.

The incidents of trade at home are totally different from those that obtain here.

England practically exports nothing raw, for coal does not affect the present argument. The manufacturer submits his goods for approval before they are packed, and once packed they are not opened till at the foreign market. Thus there is little necessity for the merchant to visit the dock.

Here, on the contrary, we deal in the produce of the soil, and scarcely two lots offered to the merchant are quite alike.

Now, trade in this produce may take one of three channels.

To illustrate them, let us fix attention on a buyer of wheat, &c., in the Cawnpore market—

1. He may sell to a Calcutta merchant who has chartered a vessel to take the wheat to England. Of course it is as easy for the Cawnpore man to send the wheat to Diamond Harbour as to Calcutta; but, when the wheat arrives at the port, the merchant must be present to take it over, not only to see that justice has been done to him in respect of quality, but also to arrange with the ship those questions as to condition which are constantly arising It will readily be seen that a merchant who has frequent transactions of this sort (that is to say, every merchant doing any considerable business) will be forced to have his representative permanently located at Diamond Harbour.
2. The Cawnpore man may refuse to sell his wheat, &c., at Cawnpore. In point of fact much wheat, &c., at present comes unsold to Calcutta; and that from many places. But if the ships are at Diamond Harbour, it is evident that wheat sent to Diamond Harbour will save many intermediate charges to which wheat sent to Calcutta would be subjected. Thus by degrees a market will spring up around the docks which will be able to undersell the Calcutta market, and thus a further exodus from Calcutta of merchants and dealers will be brought about.
3. The Cawnpore man may establish connections in England and make his own arrangements for through freight. It is only in such a case that the presence at the dock of the Calcutta merchant will be unnecessary, but not to his own benefit.

General Import Trade.

The procedure is as follows:—

After examination at the ship's side for chafage or other damage, in respect of which there may be a claim on the ship, goods are removed to the merchant's godowns, where they remain a shorter or longer time according to the markets. They are then brought by dealers who distribute to the various marts of the interior.

Now, it is quite conceivable that the Railway Company, by accepting some rather risky responsibilities, and making some rather costly arrangements, might reconcile the Calcutta merchant to receiving his goods at a Calcutta railway station. It would, however, before long be found that by placing the centre of distribution at Diamond Harbour docks instead of at Calcutta, many expenses could be saved, and that merchants established there could undersell their Calcutta competitors.

The obvious result would be the gradual migration of another set of traders.

Salt is imported by merchants in entire cargo loads. It is, however, not usually sold by the cargo, but in small parcels, to many dealers, day by day. These dealers pay the duty, and each man brings his boat alongside the vessel and takes his salt. The Customs Preventive Service watch the discharge to secure the revenue; the merchant's clerk watches it to see that no man gets salt for which he has not paid; and the captain weighs out the salt to fix his freight.

The boats which carry this salt away into the interior are those which have brought produce down.

This trade could not be carried on from Diamond Harbour so long as merchants and dealers were here, nor so long as the salt was sent up-country by boats which have discharged in Calcutta. We have, however, seen that a produce market is likely to spring up about the docks, and as arrangements could be made to discharge ships' cargoes into bonded warehouses alongside the docks, and to deliver from bond direct into boat or railway wagon (whereby very great savings would be effected), it is certain that, sooner or later, the salt trade would leave Calcutta.

The coal trade would naturally follow the steamers.

Jute baling, now an important industry here, must of necessity place itself near the ships, for the simple reason that the railways carry jute by weight, whilst the ship is paid freight by measurement. Hence the object is to bale it in as short a time as possible before shipment, in order that the least possible re-expansion may take place before measurement for sea freight.

Marine engineering.—Ship agency establishments and all the miscellaneous trades and industries dependent upon the custom of the ships are bound to move down the river.

Thus, the results of successful docks at Diamond Harbour must be the complete, though gradual, disintegration of many trades now pursued at Calcutta. It is indeed a condition precedent to their success that they shall take from us nearly the half of the vessels that now come here, and we may safely say that the process of despoilment of our shipping, once begun, must continue, for when dock No. 1 overflows, No. 2 will be excavated, and the "dockizable' space is practicably unlimited.

If these views as to trade are sound, it follows that property in Calcutta generally, but particularly that very large portion which rests upon our present position as the chief port of Bengal, must suffer very serious deterioration.

IV.—Is this injury to Calcutta called for.

Of course if the expanding commerce of Bengal could not be provided for without sacrificing Calcutta, we might have to accept the situation, but things have not yet come to this.

Various schemes have been propounded for increasing the resources of the present port be such expedients as extending the jetties to Garden Reach and utilising the Howrah foreshore, &c., &c. They deserve careful consideration, but they are open to the serious objection that they leave untouched the delays and dangers of the Hooghly.

The same cannot, however, be said of Mr. Bruce's scheme to connect the Hooghly with the Mutlah by a ship canal; although, as regards the points of entrance into the respective rivers, his proposals might perhaps be modified with advantage.

Such a canal would be about 30 miles in length. The distance from Calcutta to sea by his route would be rather less than *viâ* Saugor, and according to the latest chart, the least depth of water anywhere would be 22 feet reduced.

Comparatively speaking, not much appears to be known about the Mutlah beyond the facts that when last surveyed the channels were broad and deep and the water salt up to Port Canning. There seems, however, reason to look upon it rather as an arm of the sea than a river, and if so, there is little fear of its silting up or water failing.

The canal scheme would offer the following advantages :—

(1) The dangers and delays of the Hooghly would be at once and for ever turned.

(2) Vessels could proceed to sea at almost any time of any tide.

(3) The navigation would be so easy that any steady sea-faring man with local knowledge rapidly acquired could be trusted to pilot vessels in and out, so that pilotage charges would be susceptible of great reduction.

4. The Port estate in which so much public and private money is invested would be safe-guarded.
5. The organization of the Port Commissioners would be available for managing the canal and any docks connected therewith.
6. The extensive appliances now in the port might continue to be utilised, and further improvements might proceed without being checked by fear of their being superseded or rendered valueless by the creation of a rival port.
7. The revenues of canal (and docks) would go into one common purse, with jetty tolls and other port receipts, so that the surplus of one department would be available to cover any deficit in another.
8. The enormous cost of establishing a new town with its buildings, streets, lighting, conservancy, water, &c., would be avoided.
9. Property in Calcutta instead of deteriorating would be enhanced in value.
10. No interest (unless it were that of the present pilot establishment) would be assailed, and no man's business would be destroyed or violently disturbed, but the good of all would be promoted.
11. If the expense of constructing a dock as well as a canal were thought too great, the dock might be left for a subsequent undertaking. Meantime most of the advantages of docks would be secured by an enlargement or enlargements of the canal sufficient to allow of ships lying alongside a quay or jetty without impending the navigation.

It has been objected that the project, however otherwise good, must be set aside by reason of its cost. It does not so strike me. I have already advanced certain considerations to the contrary, and may here point out that, through all but a short section of the canal, ground could be cheaply acquired. Near Calcutta any surplus land taken up would be re-sold at an enormous profit. The docks would in fact be the chief centre of business life, and land around them and on either side of the canal would be eagerly sought after for such purposes as—

Jute presses.
Factories.
Warehouses.
Offices.
Coal yards.
Engineering shops.
Petroleum stores.
General warehouses.
Inland steamer wharves.
Emigration depôts.
Timber yards.
Graving docks, &c., &c.

I propose, however, to show that such an undertaking, even though more costly than can reasonably be anticipated, would still be remunerative, and this may probably best be done by attempting an estimate of the gross savings which would result to the shipping and to the mercantile public.

To make the estimate intelligible, it should be explained that it is assumed that (either in docks or alongside quays or jetties) provision is made (*a*) for berthing every vessel that enters the port; (*b*) for receiving her cargo at once into sheds or warehouses; (*c*) for loading such cargo out of sheds into boats or railway wagons or carts according to the destination of such cargo; (*d*) in other warehouses for receiving from boats or railway wagons a vessel's export cargo in advance, if need be, of her arrival; (*e*) and generally for proceeding uninterruptedly with discharge and loading. (It would be easy in dock to employ the electric light so as to work in the cool air of night, even better than by day.)

It is also assumed that trade would readily accommodate itself to the new conditions; that both imports and exports would be warehoused on the banks of the canal; that jute would be pressed there; that the railways, inter-urban and external, the boat canals, the ship canal, and the docks would all be so connected and worked in harmony as to facilitate and cheapen to the utmost the movement of goods, and generally that such arrangements would be made as to eliminate the double carting and boating charges, which nearly all our imports and much of our exports have now to pay.

A.—Savings by Vessels.

It is estimated that the tonnage annually visiting this port will be not less than—

400	canal steamers. The numbers for 1881 were	280
350	coasting steamers. Do. do.	292
400	sailing ships. Do. do.	462
1,150	vessels. Total	1,034

Of these the coaster could afford the least for dock or canal dues. She now loads as rapidly in the stream as could be hoped for in dock, and her comparatively light draught minimizes detention.

	R		R		R
She would, however, by using the canal save probably half a day, valued at . .	225				
And in pilotage,* say	400				
	625	×	350	=	2,18,750

The larger canal boat would save—

1 day in the river, valued at . . .	560				
2 days in loading and discharging . .	1,120				
In pilotage,* say	550				
	2,230	×	400	=	9,92,000

The sailing vessel would gain most of all.

Of the ships which came here in 1881—

40°/ₒ	were in ballast and averaged	33	days in port.	These could save at least	20 days.
37°/ₒ	„ salt laden „	49	„	„ „	29 „
15°/ₒ	„ with general cargo „	45	„	„ „	25 „
8°/ₒ	„ „ coal „	40	„	„ „	20 „

So that the average saving per ship in time might be 24 days.

	R		R		R
24 days, at say, R200	4,800				
Pilotage saved*	450				
Saving in tug hire, say	1,000				
	6,250	×	400	=	25,00,000

	R
Saving by ships	37,10,750

B.—Savings by Merchants on Boat and Cartage expenses.

SALT.—The imports now are over 300,000 tons, whereof about one-third has to be warehoused. Taking credit for only 10 per cent. increase in consumption, the saving in charges on the one-third portion bonded would be	1,40,000
COAL.—The saving would only be on the portion used by steamers, say 100,000 tons, at R1	1,00,000
GENERAL IMPORTS exclusive of salt and coal. (No figures showing the number of tons imported seem to be available.) I assume 500,000 tons at R1-12	8,75,000
JUTE.—Present export 334,385 tons. We may pretty safely reckon on an increase of export to 500,000 tons. Let us take the saving in charges at R1-8, although, if the jute presses were located on the canal banks, the saving would be very much larger	7,50,000
GRAIN, SEEDS, &C., BROUGHT INTO CALCUTTA BY RAIL.—Mr. Leslie has shown that the East Indian Railway alone will bring in 1,250,000 tons. From all railways, therefore, let us say 1,500,000 tons, at R1-8 . .	22,50,000
OTHER PRODUCE NOT BROUGHT IN BY RAIL.—If stored in godowns on the canal bank, there would be large savings in cartage, boat hire, &c.; but let us say only	3,00,000
	81,25,750

If now we imagine the cost of land, canal, docks, and warehouses to amount to the surely excessive sum of 350 lakhs, the account will stand thus:—

	R	
Interest on 350 lakhs, at 4 per cent.	14,00,000	
Maintenance, conservancy, and working staff, say . . .	4,00,000	
Sinking fund, say	7,00,000	
Per annum . . .		25,00,000
Balance available for lightening charges on shipping and on trade generally, after providing for deficit (if any) in the accounts of the Port Trust, *viz.*, deficit caused by a falling off in receipts owing to transfer of business to the new docks		56,25,750

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* *Memo.*—If it were considered essential to maintain the present staff of Hooghly pilots, the saving in pilotage here shown (amounting in all to R5,40,000) could not be fully realised; but I believe that after a time it would be found unnecessary to maintain the Hooghly establishment.

I need scarcely say that this is the roughest of estimates, and that it may probably need correction on both sides of the account. There are figures necessary for nearer estimates which are not available to me. The savings of trade have, however, not knowingly been overstated. On the contrary, present charges are not set down at their full amount per ton, nor have I included in the account such items of legitimate canal revenues, as tolls on inland steamers, and other craft using the canals. Then, again, I have tried to put down the cost of the canal system, and of its maintenance, at figures not open to challenge on the score of being too low, and I may have erred largely on the safer side. Lastly, I have not attempted to state the depreciation of property at Calcutta, which would follow upon the diversion of trade to Diamond Harbour; nor the rise in the value of such property which must naturally come about if we can succeed in preserving to Calcutta her character as the port and chief distributing centre for the whole of the rapidly-increasing commerce of Bengal.

I submit, however, that I have made out a *primâ facie* case in favour of Mr. Bruce's scheme; that such a project, commanding as it would the vote of the Calcutta interest, would pay more certainly and more rapidly than one which involves dragging merchants and dealers against their will away from this port; and that, at all events, we should advise Government to consider exhaustively the merits of the Mutlah and other alternatives before proceeding with the construction of docks at Diamond Harbour.

(Circular letter issued with questions.)

Dated Calcutta, the 21st January 1882.

From—The President of the Committee on Docks at Diamond Harbour,

To—

A Committee appointed by the Government is now enquiring into the merits of a proposal to construct deep water docks at Diamond Harbour, with a view to add generally to the commercial facilities of the port, and to give to the shipping that greater security which their ever-increasing size and value appear to demand.

The scheme so far as it has assumed any shape as yet, which has been suggested for the consideration of the Committee, is as follows:—

(1) A dock 4,000 feet by 500 feet, a half-tide basin about 800 feet square, entered by two locks—one 80 feet and other 60 feet wide. This would provide quay berths averaging 360 feet long for about 30 vessels, and at the same time would allow space towards the centre of the dock for other vessels either discharging into boats or waiting cargoes.

(2) The docks, including an area for probable extension, and all dock buildings, railways, &c., to be surrounded with a strong embankment or bund raised about eight feet above the level of the great cyclone flood of 1864, with storm-gates of the same height, pointing outwards. The surplus material from the excavations to be used to raise the general level of a portion of the land near the river to the same height as the dock embankment.

(3) The dock and accessories as sketched above will cost approximately one million sterling. The railway charge for goods between Calcutta and the docks will be about one rupee per ton.

(4) The docks to be provided with suitable warehouse and all modern appliances for the rapid working of cargoes of all kinds. Rails, in connection with the railways to all parts of India, to be brought down alongside of the vessels.

By fixing the site at Diamond Harbour, the James and Mary shoal and several other dangers are avoided; it is near a good anchorage ground, and the dock is practically within one and a half hour's run of Calcutta by rail.

Understanding that you are able to afford valuable information, which will materially assist the Committee in forming a conclusion, I have the honour to request you kindly to answer, to the best of your ability and at your earliest convenience, such of the following questions as come within the range of your experience.

The Committee will be much obliged if, in answering the questions, you will indicate any reports, returns, or other sources of information from which the particulars which they desire to know may be ascertained. The answers should be sent to "The Secretary to the Committee on Docks at Diamond Harbour, Writers Buildings, Calcutta."

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(1) What are the really important shoals and other recognized dangers in navigating the Hooghly up to Calcutta, and what, in your opinion, would be gained generally by vessels terminating the voyage at Diamond Harbour.

Messrs. Henderson & Co. say:—The James and Mary shoal we understand. For a time a saving of port dues. Ultimately little or no advantage.

Messrs. Gladstone, Wylie & Co. say:—Below Diamond Harbour are the Gasper and Bellary Bars. Above are the James and Mary's and Moyapore Bar. The chief advantage of terminating the voyage at Diamond Harbour would be the avoidance of the upper bars. For some years past, though larger vessels have been coming to this port, there have been very few casualties in the river.

Captain Yates, Harbour Master, says:—Important shoals are Gasper Channel, Eden, Jellingham Bar, Huldia Bar, Bellary Bar, below Diamond Harbour; James and Mary's, Moyapore, above Diamond Harbour. Other recognised dangers are strong tides and eddies. The advantages gained would be avoidance of the eddies principally above Diamond Harbour. The narrow navigation of the upper reaches anchoring in the narrow dangerous in the freshets and the shortening of the outward passage one day in most instances.

Lieutenant Petley, R. N., River Surveyor, says:—Gasper Channel, Jellingham, Huldia, and Bellary Bars, James and Mary shoals, Mynam Reach, Fultah Point, Moyapore Flats, and Monikholly Point during the freshets.

Vessels by terminating their voyage at Diamond Harbour would avoid the dangers above the James and Mary.

Lieutenant Stiffe, I. N., Port Officer, says:—

At present—	Gasper Jellingham Huldia Bellary	below Diamond Harbour.
	James and Mary's Moyapore Monikholly Point	above ditto.

(*b*) The avoidance of the last named, which is especially desirable in the freshets.

Middle Ground.

Mr. Elson, Master Pilot, says:—Besides the Saugor sand on the eastern side of the Eastern or Main Ship's Channel, and the Eastern Sea Reef on its western side, the first shoal or danger which a vessel meets with on her way from sea to Calcutta is the Middle Ground, on the tail of which, in heavy weather, the sea breaks. This sand extends from a half way up this channel for a distance of about 12 or 14 miles, forming with the Eastern Sea Reef to the southward the western boundary of the Eastern Channel. Its head forms the western boundary also of the Gasper Channel, but the tail of this sand is avoided by keeping well over towards the intermediate light to the eastward, where deep water is found.

Gasper Channel.

The Gasper Channel is the second danger to be encountered, which is a gut of water, with at present 19 feet of water in it at low water springs, running north-west between the head of the last-mentioned Middle Ground and the Middleton Sand on its eastern or northern side. There is always more or less swell felt here, and therefore experience and judgment are needed to make allowance for it, so that a deep vessel shall not strike on the hard bottom whilst passing through it. It is in length 5¾ miles, and is marked by six buoys and also at either end by a floating light-vessel—the Lower and Upper Gasper lights. The Lower Gasper is 24 or 25 miles in a direct line north by west from the outermost on Eastern Channel light-vessel.

Middleton Sand.

The next shoal is the lately extended spit of Middleton Sand, a hard sand environing the south-west and south extremity of Saugor Island, which, by encroaching to the southward and westward, has made the navigation of this part of the main ship channel one of no little peril by night in the south-west monsoon, seeing there is no light or lights to guide to, or mark, the deep water anchorage in the upper part of Saugor Roadstead. And in the dirtiest weather of the southwest monsoon sailing ships are only able to get a favourable wind on the night's tide when bound in, the winds of the daytime having too much of westing in them to allow ships to sail through the Gasper Channel.

Long Sand.

The Long Sand, too, is a formidable danger by night, as the water is deep close alongside its eastern edge, which is the western limit of Saugor Roadstead. It is only covered by the sea when the tide rises to 19 or 20 feet.

Saugor to Kulpee.

The next dangers are the whole of the sandy shoals lying between the upper part of Saugor Roads on the south and Kulpee anchorage on the north, a stretch of 30 miles. Between these several sands run at present: the Eden, Auckland and Dredge, Jellingham, Huldia and the Bellary channels, with anchorage of 30 feet below Mud Point, or about half-way between Saugor and Kulpee.

All these channels are constantly shoaling, deepening, and changing their courses, and over which the staff of the River Surveyor have to keep constant watch, as the freaks of the stream cuts new ways through the sands, and piles it up in the old ones.

At present the least depth of water in any of these shifting channels is 13 feet 6 inches at low water springs, but there are times when we have no more than 9, 8, or even 7 feet in them; but fortunately these times are rare, the stream always deepening out in some other direction.

Above these sands of the estuary there is spacious and deep anchorage at Kulpee, five miles below Diamond Harbour, and a moderately broad and deep water channel to Diamond Harbour anchorage.

Diamond Harbour to Calcutta—Kookrihatti lumps.

The first danger above Diamond Harbour is the Kookrihatti lumps forming a shoal from the south or right bank of the river to three-fourths the distance across at times, but they are avoided by keeping to the north, but at present they are no serious obstacle to the navigation.

Eddies off Luff Point and in Hooghly Bight.

The second danger are the eddies off Luff Point immediately above these last lumps; they are strong on the springs. Here also on account of the course of the channel altering from west at Raychuck to west-south-west makes it a difficulty for sailing ships to luff into this reach or Hooghly Bight, for there is the tail of a sand close to on to which the flood tides set strong. In fact all round Hooghly Bight the eddies are bad, and although there is deep water right through it, it is an unsafe anchorage for all vessels in the springs or during the freshets. Hooghly Bight forms the large segment of a circle, the course at its lower part being west-south-west, and at its upper part, at the point where begins the crossing over to the eastern gut of the James and Mary's, the course is about north-west.

James and Mary's.

The James and Mary's shoals may be said to include the whole of the sands about the junction of the river above Hooghly Point running north-north-east with that which runs west on up the river Roopnarain, namely, the Muckraputty lumps, Noorpore lumps, and Anchoring Creek Ridge occupying the centre of the river, and which are at certain seasons and places dry at low water. There are channels on either side of these sands, called the eastern and western guts, running up with the contour of the river banks, north-north-east to north-east by north.

The eastern gut opens out and deepens with the advent of the freshets which sweeps the accumulated sand from above and off Hooghly Point around and below it, so that by October the freshets have scoured out a channel of perhaps 24 feet, where there may have been in May or June only 7 or 8 feet.

I see by an old record of the depth of water in the eastern gut that—

in October 1866 there was 20 feet 9 inches;
„ July 1867 „ „ 6 „ 3 „
„ October „ „ „ 21 „ 0 „
„ June 1868 „ „ 6 „ 6 „
„ October „ „ „ 21 „ 0 „
„ June 1869 „ „ 8 „ 3 „
„ October „ „ „ 18 „ 0 „
„ April 1870 „ „ 8 „ 0 „
„ October „ „ „ 21 „ 6 „

and so it continues to the present time, opening and closing with the seasons; year after year the same round goes on, but I think I remember one season, some years back, when there was not more than 5 feet right across the river, that is, this was the most water to be found anywhere through which a vessel may pass up to Calcutta. I wish I had the record by me, as this fact must be of vital interest as bearing on the question of docks at Diamond Harbour. The western gut also opens and closes with the seasons, the change being in the opposite direction, that is, the freshets close this gut, but this bar seldom has more water on it than what is to be found in the eastern gut in the dry season, and moreover the depths on it are liable to sudden change.

The closing up of the James and Mary's takes place at that season of the year when the mean half tide level of the river is low, and consequently deep-loading vessels requiring over 22 feet have sometimes had to go to Diamond Harbour to finish loading at such time.

Fortunately the James and Mary's have been good of late years, so that much inconvenience has not been felt by vessels being obliged to leave Calcutta only half loaded.

The passage through the eastern gut of the James and Mary's has always been considered, and undoubtedly is, fraught with some amount of risk and uncertainty on a spring flood tide when the eddies are strong, as will appear by the following old standing order to pilots:—

> "Within three days of the full or change of the moon, no sailing vessel drawing more than 12 feet shall attempt to pass the James and Mary's inward bound on the flood tide, unless in tow of a steamer."

We also read "vessels may not be under weigh at night between Gowawkolly Temple and Fultah Point, or over the James and Mary's under any circumstances."

The danger of the passage upwards of the James and Mary's (eastern gut) consists, firstly, by the tendency of the flood-tide, as it makes past Hooghly Point, to sweep a vessel on to the Muckraputty lumps, or if she escape that, there is a risk of the tide, as it bears against her afterpart whilst her bow runs into the slack above the Point, swinging the vessel on to the Point, parting her hawsers if in tow, and then of running ashore upon it.

These eddies off the Point must be encountered by vessels of deep draught passing both up and, down, seeing that the tide falls some two or three feet before it turns or there is any slack water.

Nynan.

Above the bar of the western gut up the James and Mary's is the Shibgunge Sand and then Nynan lumps, both of which sands, on account of the disturbing eddies which rise as the stream of the Hooghly unite with that of the Damooda immediately above, are constantly altering the depths of water upon and between them, so that both on this account and on account of the violent eddies, Nynan is a forbidden anchorage for all vessels.

Fultah Point.

Like the eddies above Hooghly Point, there are bad eddies above Fultah Point, as the flood tide sets right across the channel on to the tail of Fultah Sand, and the channel being narrow above it is also a point of risk on the flood tide.

The space (8 miles only) between the James and Mary's and the anchorage at Fisherman's Point has been famous for the large proportion of wrecks, as the following list of vessels lost during the last twenty year shows:—

Waterton.
Daphni.
Victor Emanuel.
John Vanner.
Agamemnon.
Huron.
Bollingbrook.
Ethel.
County of Stirling.

Queen Anne.

In all these ten cases lives have been lost, and the losses of the ships have been due to the perils of the navigation. During all this time only 16 ships have been lost below the James and Mary's.

An inward bound ship, after passing Fultah, can be considered to have passed all danger (of course I mean on the last of the flood tide).

Fultah Reach.

Fultah Reach is also a very narrow and often a shoal channel where passing vessels have to be navigated with great care; the channel like Noorpore immediately above the James and Mary's being but a little over 100 yards broad, and besides curving round and forming a large segment of a circle with such a small radius that the helms of long vessels have to be kept almost continually hardove whilst passing through it.

Royapore Flat.

Royapore Flat is the next danger, but as there is, and has been for years past, as much or more depth of water than at Moyapore Flat, 3½ miles above it, it is not much of an impediment to navigation. There is at present 18 feet upon it at low water springs.

Moyapore Flat.

Moyapore Flat or crossing sometimes forms a serious obstruction and barrier to navigation, the sand of which it is composed shifting and forming lumps with sometimes only 7 feet on them in a most eratic manner. At present we have 17 feet on this bar; it is 19 miles below Calcutta.

Monikholly Point.

Monikholly Point, and the usual sand below it, is, on account of the whirling eddies found off it on the ebb tide, a formidable danger to vessels passing down on the springs or in the freshets. These eddies are caused by the river taking such a very sharp turn. Above the Point the river runs about north-north-west and south-south-east, whilst below it, it runs south-west and north-east.

Sangral Reach.

Sangral Reach is very narrow, and as it too has eddies on the ebb tide, it is a danger to long vessels coming down on the ebb tide, especially if another long vessel happens to be passing up at the same time, as at the spot where it is only 120 yards wide, it comes round in a quadrant with a radius of only 1,000 or 1,100 yards, or from north and south to east by south and west by north.

Fisherman's Point.

Another source of danger is the anchorage at Fisherman's Point, as it is full of eddies on the ebb in strong springs and during the freshets; and at times, when the depth of water on the James and Mary's is small, vessels must anchor here for the night, it being the only available anchorage between Budge-Budge and James and Mary.

Diamond Harbour and its good points.

If vessels terminated their voyage at Diamond Harbour, besides avoiding all these enumerated perils and dangers, they would arrive at that spot at half-flood generally, and could be easily docked or moored ready for discharging cargo the same day, instead of, as at present, being compelled to wait there till after half-flood before they can start on their way up to Calcutta.

Diamond Harbour is very conveniently situated with regard to the prevailing wind direction in the summer or south-west monsoon for rounding sailing ships when under sail and anchoring them.

And this anchorage is also a favourite one with pilots during strong winds from the southward, as it being abeam, the vessel rides in safety without the fear, as at all the other anchorages (which run nearly north and south), of a vessel shouldering her anchor on the ebb or weather tide.

Although it is forbidden, except in cases of emergency, that pilots should be under weigh with vessels above Saugor without the aid of steam in vessels of over 20 feet draught, if there was a strong breeze from south-west and flood tide, I should prefer running to Diamond Harbour than risk "rounding to" below, even if the vessel was over the prescribed draught; but of course if Diamond Harbour was likely to be full of ships, it would have to be considered, as would, too, the state of the channels.

Mr. Milner, Branch Pilot, says:—The Middle Ground joins the Gasper Sands, their united length being 11 miles, forming the western boundary of the Gasper Channel, and confining the working breadth of the channel to 2 miles immediately below the Lower Gasper light-vessel to 2¾ miles at the centre Saugor Sand buoy. This is an important and dangerous shoal, obstructing the entrance into Saugor Roads, specially to large deep-sailing ships navigating, during the south-west monsoon, in the vicinity of the Gasper, in consequence of their liability to become unmanageable in heavy seas by suddenly encountering (perhaps at night) violent north-west squalls with blinding sleet; compasses not to be depended on, and a crew numerically incompetent to handle a ship so placed, when having clewed up for the semblance of a north-wester which kills the southerly wind, leaving the ship drifting about helplessly in a calm without anchorage.

By the tug of a large outward-bound ship breaking down when below the Lower Gasper light, or being incompetent to tow on account of the strong wind and heavy sea, hawsers parting, the tide having ebbed too much to return, the inability of the ship to stay in the heavy sea, as is the case in strong south-west monsoon weather, too heavy to anchor in, which if attempted, and the chain parts, the vessel must inevitably become a total wreck, the incompetence of such crews as are supplied to ships in the present day to work a ship in such a narrow channel in such weather.

Take the instance of the steam tug *Court Hey* breaking down with the ship *County of Inverness* in the Gasper Channel. This vessel drifted helplessly on to the Middle Ground, sustained severe damage through bumping, and had to return.

These are all possible circumstances of great risk to ships pointing to the dangers of this vicinity, besides which the Gasper Channel, although considered to have been very good with 19 feet reduced in it for some years past, is liable to change, the ship *Harvest Home* in ballast drawing 13 feet having bumped in this channel (in 1859 I think).

To enumerate all the many risks and disasters which have occurred to vessels in this vicinity is hardly necessary, as there can be but little difficulty in recognizing this obstruction as a very dangerous one.

The shifting nature of the Middleton Sand has had a very serious effect by encroaching and narrowing the channel so much, especially near Saugor Anchoring Buoy, dangerously affecting the navigation for heavy vessels at night in hazy and rainy weather. Saugor Roads, which was once a fine, broad and deep roadstead, has so alarmingly deteriorated that a heavy steamer coming in at night has to be navigated with considerable judgment to find anchorage on the spring tides.

The channels between Saugor and Kulpee are all of the same shifting and unreliable natures, at times there being only nine feet reduced over their bars, causing vessels to be neaped and otherwise much delay, the depths increasing for a time when a few ships find out the alteration by grounding, and what was the channel is replaced by a dry sand.

The Muckraputty Sand of the James and Mary is one of the most dangerous sands in the Hooghly, and the periodical closing up of the eastern gut in the months of March, April, May, and June often causes very serious delay, inconvenience, and shutting out cargo in the case of very deep loading steamers.

The danger in navigating upwards at the James and Mary's is caused by vessels having to cross from Hooghly Bight for the entrance of the eastern gut across a strong flood tide, setting the vessel up bodily towards the Muckraputty lumps, enforcing the pilot to port his helm, thus causing the vessel to angle across the gut or narrow channel towards the eastern bank, so that, when the bows of the vessel enters the slack tide (which is caused by Hooghly Point cutting off the flood tide from setting fair round up the channel), she is influenced to rapidly sheer to starboard against her helm with the risk of grounding on the flat off Hooghly Point, and in the case of a ship in tow to part hawsers in the same effort.

The reason vessels enter the eastern gut on a strong flood tide is because in the freshets there would be an uncertainty of their getting up to town if they did not do so, and at other times of the year from an unwise impatience on the part of the officer in charge to go ahead for no actual advantage than to perhaps gain a turn.

The danger of navigating downwards at this place is greater in the case of ships in tow than steamers on account of their liability to part hawsers by sheering when entering the flood tide, being thus swept up and grounding on the Muckraputty lumps before they can be brought up by weak crews, generally further incapacitated by debauchery and strong drink. This is also an awkward place for vessels meeting, especially on the flood tide.

Ships have also lost anchors and cables and grounded on the bank in Hooghly Bight by crossing out of the eastern gut on the last of the ebb tide in the freshets; but this, I think, is the result of imprudent and unskilful navigation.

The western gut is not used generally except by very light vessels and steam-tugs, there being only two to four feet reduced as a rule.

Nynan is a most dangerous place as an anchorage, especially in the freshets, on account of the strong eddies both on the flood and ebb tides, causing a ship to become quite uncontrolable, and heeling her gunwales under on a strong sheer if the cable will hold.

The flood tide runs exceptionally strong here, which is caused by the contour of the bank of the western gut setting the tide over towards the Nynan marks, from whence it runs up in a line of great force the uncontrolable eddies on spring tides, when the flood is just in. This strong line of flood tide causes much risk of parting hawsers to a vessel entering it from a slack under Fultah Point. Many fine ships have been lost on Fultah Sand from these influences.

The danger to a vessel coming up is of grounding on the bank in Fultah Reach being affected the same way as on entering the eastern gut.

The anchorage at Fisherman's Point is dangerous on spring tides in the freshets on account of the strong line of eddies and slack tide on the ebb caused by Hog River sand. This line of eddy tide keeps moving in and out towards the eastern and back towards the western side of the river, the effect being that at one time the ship is lying in a slack angling with her head towards the western bank, and as the line of eddy moves in her bow is caught by the strong tide, paying her head down the river, causing the windlass to be almost torn out of her, the cable to part, or the ship to drive perhaps on shore. Pilots do not anchor vessels here from choice, but because there is a larger area of deep water than any other place below Garden Reach, and it is necessary that ships should anchor near the James and Mary's as possible to enable the tug steamer to tow them across the eastern gut when it has become bad, which happens when it blows the hardest from the southward, and we have the strongest floods. It was here that the steam-ship *Queen Anne* was lost—the only steamer that has met with such a fate to my knowledge since the opening of the Suez Canal, and it must be remembered that a junior pilot was placed in charge of a branch pilot's work.

Moyapore Flat is a dangerous obstruction on account of its liability to sudden changes; many ships ground here. The barque *Cecelia* capsized here some years ago, and the pilot, Mr. Alfred Fielder, and some of the crew were drowned. This shoal also causes much detention to vessels.

The river off Monikholly Point on spring tides in the freshets is a place that is much dreaded on account of the uncontrolable eddies, and it is undoubtedly a relief to the pilot on the way down to find himself safely past this place. Vessels, however, seldom ground on the sand, the tendency being to run on the southern bank near the crossing mark.

In terminating the voyage at Diamond Harbour, there would undoubtedly be much less risk of accident, principally to sailing ships, besides less chance of loss of anchors and cables; and although steamers have been navigated so successfully, the dangers still remain, and vessels would not be threatened with detention on account of strong spring tides in the freshets.

All sailing ships up to 20 feet draft would endeavour to sail up to Diamond Harbour, if that were their destination, when the winds were favourable, as in the south-west monsoon; even ships over that draft if they were not prohibited by the regulations, which would be a substantial saving in steam-hire inwards.

Many ships would sail up to Diamond Harbour under present circumstances were it not for the knowledge that they would have to pay nearly as much from there as from Saugor, which decides the question of their taking steam from the latter place. A considerable saving in steam-hire would be effected with such ships as the *Cuba, Simla* class, though how much it would be difficult to say; probably R3,000 or R3,500, both ways included.

Deep-laden inward vessels would occasionally be saved detention from being neaped in the months of April, May, and June, and would at times terminate their passage a day earlier.

No estimate can be arrived at as to what would be the gain in time to outward-bound vessels leaving Diamond Harbour docks instead of Calcutta, unless it is first known at what particular time of tide a vessel may be undocked, *i.e.*, suppose such a steamer as the *City of Agra*, drawing 24 feet 6 inches, was to leave on the second day of the springs, or any day later up to the third day of the neap tides, and could not leave the dock till high water, she would have to anchor at Kulpee.

The same steamer, at a like draft, leaving Calcutta on any of these days of the tide, would also anchor at Kulpee.

It follows that if a heavy draft vessel cannot leave the docks till high water, she would always be detained about 20 hours, except the fifth and sixth day of the neaps, and perhaps quarter day from April to August, when the day breaks early, enabling the vessel to come out of dock, go to Kulpee, and proceed on the afternoon's tide.

Allowing that the Diamond Harbour vessels, both of light and deep draft, could take every advantage of meeting the flood tide at Kulpee, a relative gain of time may be arrived at approximately against those leaving Calcutta at every draft at all times of the year; but pressure of time and duties will not admit of my working out this somewhat extensive calculation.

On the strong floods in the months of March, April, May and June, when the eastern gut of the James and Mary's has closed considerably, sailing ships would sometimes be saved two days' steam-hire, besides so much time in leaving from Diamond Harbour.

Mr. Grimley, Collector of Customs, says:—The general gain to vessels, if it were possible to terminate the voyage at Diamond Harbour, would, it appears to me, be—

First.—The avoidance of the dangerous "James and Mary" shoal off Hooghly Point, the strong eddies at Fultah Point and in the Nynan Roads, which are important considerations, especially to vessels of any length of build or depth of draft, which compel them to anchor at Diamond Harbour, on their way up the river, either in consequence of nightfall, or to await a favourable tide to enable them to cross the shoals above Diamond Harbour. The detention caused on this account varies from 6 to 12 hours according to the circumstances of each case.

Second.—The great saving of time by curtailment of the distance between Diamond Harbour and the Port of Calcutta, the attendant delays in hauling after arrival from the anchorage in the stream to a fixed berth, or to the jetty head for facility of working.

Third.—The greater safety to vessels within the docks from cyclonic influences, as the dyke which it is proposed to construct eight feet above the ascertained height of the highest known storm-wave will most probably form a snug resort for vessels.

Fourth.—A saving in pilotage charges.

Captain Wilkinson, Superintendent, P. & O. Co., says:—The "James and Mary" and the Moyapore Flats. Vessels are sometimes neaped inward-bound and have had to wait as much as two days at Diamond Harbour, and vessels arriving late in the river have had to anchor at Diamond Harbour for the night.

During the freshets it is very common for ships to anchor at Fisherman's Point, which is at that season a very dangerous anchorage.

Captain Thompson says:—Above Diamond Harbour, the James and Mary's, Moyapore, Fultah and Monikholly Points. These dangers would be avoided by vessels remaining at Diamond Harbour, which would be most advisable during the freshets, but not much else to be gained that I can see for ships or steamers of the size which at present come to Calcutta.

Mr. Daly, Branch Pilot, says:—The Gasper. At present the Eden, Jellingham, Huldia, Bellary, James and Mary's, Fultah, Royapore, Moyapore, ships would save one quarter of the pilotage and avoid navigating the narrow reaches of the river above Hooghly Point.

Messrs. Apcar & Co. say:—The dangers above Diamond Harbour are the James and Mary, Nynan, Royapore and Moyapore, and below Diamond Harbour the Jellingham, the Huldia, and the Bellary bars. Till quite lately there has been less water on the bars below Diamond Harbour than those above. At present the James and Mary seems to be deteriorating, and we believe has only 13 feet rise of tide.

Messrs. Gillanders, Arbuthnot & Co. say:—In the case of vessels terminating the voyage at Diamond Harbour, there would be a saving of from two or three days' time at present occupied in proceeding to and returning from Calcutta, and presumably of port charges as detailed under questions 29-30. Vessels would also avoid the risks of the river between Diamond Harbour and Calcutta, and if suitable docks were made, there might be a further saving of time, and consequently of expenses.

The Committee of the Bengal Chamber of Commerce say:—Below Diamond Harbour the following shoals, *viz.*, Middle Ground, Gasper, Middleton Long Sand, Jellingham, Huldia, and Bellary.

Above Diamond Harbour the following, *viz.*, James and Mary, Nynan, and Fultah Reaches, Royapore and Moyapore Flats, Monikholly Point. Also many dangerous eddies.

By terminating the voyage at Diamond Harbour the dangers in list No. 2 will be avoided, time and pilotage will be saved, and in case of sailing vessels also steam-hire.

Mr. Joseph Richard Wells, Branch Pilot, says:—In reply to the above question, comprising a subject of such magnitude, it would be almost impossible to treat fully on each recognized danger. Those who are intimately acquainted with the navigation of the Hooghly do not require to have its dangers graphically depicted, and those who are not so intimately acquainted (with some exceptions) know that the Hooghly is, and has from time immemorial been known and allowed to be, the most dangerous navigation in the world. Since the opening of the Suez Canal,* the trade to Calcutta has undergone vast changes, notably in the build of sailing vessels and steamers, especially the latter, of such a length and carrying capacity, as well as draught, which though not increasing in the same ratio as the carrying capacity, yet vessels† drawing 23 feet and upwards are now much more the rule than the exception, and the results of the science displayed by the naval architect have achieved such success as to surpass the most sanguine expectations of those who either by invested capital, or other self-interested cause, have watched with satisfaction the growth of commerce between Europe and India since the opening of the Suez Canal.‡

* 20th November 1869.

† Sailing vessels and steamers.

‡ 20th November 1869.

Important Shoals.

1. Decrease of depth of water in the Gasper Channel, being that part of the navigable channel immediately below Saugor. This channel has been exceptionally favourable, having not less than 19 feet (reduced to zero low-water spring tides) since the 31st January 1870; and though at present there is no indication that would lead one to suppose that it shows any tendency to narrow or become more shallow, yet the depth of water in this channel, or channels in this section of the river in the past, is not unworthy of attention.

In December 1853 and January 1854 the depth of water reported in this channel was 15 feet reduced, and this was not anywhere, but only in a given track; out of the best track there were patches of only 12 feet.

In February 1855 there was no improvement, and on a lump that had formed there was only 10 feet 6 inches.

An examination of the chart below Saugor seawards will show the immense quantity of sand there is stretching out and extending the whole width of the channel on either side of the present Gasper Channel, should the present channel shoal to 16 feet. The trade to Calcutta dependent upon the entrance of the Hooghly for vessels of the present heavy draught would be attended with considerably more risk and much detention, which I will endeavour to shew in the following statement:—

Explanation of Table.

This calculation can be accepted only as an approximation based upon the tables published in 1877, compiled by Mr. S. Reed, Assistant Surveyor.

The rise of tide is for moon in Perigee, which being higher than Apogee, the detention here notified may be more rather than less.

The calculation for water in the Gasper is on the supposition of its shoaling from 19 feet to 16 feet.

	Rise at Upper Gasper Light.	Days.	Depth of water.		No. 5.					Days.
	Ft. Ft.		Ft. Ft.		Ft. Ft.		Ft.			
January .	9 to 10	2	16=26	deduct	2=24	Vessels	25	would be detained	...	2
	10 to 11	9	16=27	,,	2=25	,,	24	,, ,,	...	...
	11 to 12	5	16=28	,,	2=26	,,	23	,, ,,	...	...
	12 to 13	11	16=29	,,	2=27	,,	22	,, ,,	...	...
	13 to 14	3	16=30	,,	2=28					

	Rise at Upper Gasper Light.	Days.	Depth of water.		No. 5.					Days.
	Ft. Ft.		Ft. Ft.		Ft. Ft.		Ft.			
February .	9 to 10	6	16=26	deduct	3=23	Vessels.	25	would be detained.	...	10
	10 to 11	4	16=27	„	3=24	„	24	„ „	...	6
	11 to 12	6	16=28	„	3=25	„	23	„ „	...	...
	12 to 13	4	16=29	„	3=26	„	22	„ „	...	...
	13 to 14	10	16=30	„	3=27					
March .	9 to 10	5	16=26	„	4=22	„	25	„ „	...	12
	10 to 11	3	16=27	„	4=23	„	24	„ „	...	8
	11 to 12	4	16=28	„	4=24	„	23	„ „	...	5
	12 to 13	3	16=29	„	4=25	„	22	„ „	...	...
	13 to 14	15	16=30	„	4=26					
April .	9 to 10	1	16=26	„	4=22	„	25	„ „	...	10
	10 to 11	5	16=27	„	4=23	„	24	„ „	...	6
	11 to 12	4	16=28	„	4=24	„	23	„ „	...	1
	12 to 13	3	16=29	„	4=25	„	22	„ „	...	...
	13 to 14	17	16=30	„	4=26					
May .	9 to 10	...	16=28	„	4=24	„	25	„ „	...	7
	10 to 11	...	16=28	„	4=24	„	24	„ „	...	...
	11 to 12	7	16=28	„	4=24	„	23	„ „	...	...
	12 to 13	4	16=29	„	4=25	„	22	„ „	...	...
	13 to 14	19	16=30	„	4=26					
June . .	9 to 10	...	16=29	„	4=25	„	25	„ „	...	...
	10 to 11	..	16=29	„	4=25	„	24	„ „	...	...
	11 to 12	...	16=29	„	4=25	„	23	„ „	...	...
	12 to 13	5	16=29	„	4=25	„	22	„ „	...	...
	13 to 14	25	16=30	„	4=26					

The deduction in column No. 5 is an allowance made for waves in ordinary monsoon weather.

The detention to vessels would be both inwards and outwards.

Doubtless some may look upon the foregoing statement as the opinion of an alarmist, but when it is proposed to construct docks half-way up a river at a cost of one million sterling, nothing ought, in my opinion, to remain unconsidered that may tend to frustrate the scheme in contemplation, and now being submitted to the opinion of a Committee.

I fear the shoaling of the Gasper Channel more than any other contingency, for the reason that, whilst the upper part of the river may, from the scouring it receives during the freshets which prevail between the months of July and October, almost always have a navigable channel, so as not materially to obstruct navigation, the Gasper does not receive the same amount of dredging during the freshets owing to heavy sea; and on reference to previous charts and reports, it will be seen that the shoals in this vicinity remain in existence longer than in the upper parts of the river; and from the same cause the present deep water channel may remain open longer. It is not unworthy of note that the channel between the eastern edge of the Middle Ground, below the Lower Gasper light-ship, to the western edge of Saugor Sand is narrower and more shallow now than it was in 1870, the date on which the present Gasper Channel was reported to have 19 feet throughout it, reduced to low water spring tides.

Shoaling of Saugor Roads.

This has been subject to some very important changes during the last three or four years, showing a tendency to decrease in depth, and to limit the safe anchorage for vessels of heavy draught.

It often happens that vessels, especially sailing ships dependent on "tugs," are compelled to remain at anchor in Saugor Roads owing to the south-west monsoon being unusually strong. This I experienced in a ship called the *Birmingham*, 1,408 tons, draft 22 feet. During April 1866 the sea was very heavy. I had veered to 60 fathoms of cable.

I was at anchor in these Roads in two cyclones, *viz.*, 1st November 1867 and 15th October 1874. In the first I lost all my masts, except mizen, ported and drove on shore on Saugor beach; in the latter I lost nothing, but drove, with 2 anchors, whole cables on each, about a mile. By comparing charts, it will be seen that deep anchorage is not so plentiful; and as the sea runs very high during cyclones and bad weather, deep anchorages are necessary to ensure a ship from bumping.

The shoaling and narrowness of the channels between Saugor and Diamond Harbour.

This depends entirely upon the course of the river in its unfettered flow, especially during July and October, when the freshets cause a scouring in one direction and an accumulation in another, that no dredging or artificial means could contend with or divert. Some idea of the volume of water may be gathered from the fact that at Middle Point* the tide rises in September 22 feet and upwards, falling to zero.

The Rangafulla Channel is more subject to sudden changes than any other part of the river (between Hooghly Point and Fultah Point excepted).

In a letter No. 243 of 4th October 1867, the River Surveyor reports that some parts of this channel are changing almost weekly.

So extensive are the changes in the Rangafulla, that between 28th August to 16th November 1869, a space of 80 days, it was necessary to move a buoy 1,300 yards.

The Rangafulla Channel has been very little used since February 1875; in its lieu the Bellary has been used, no channel having been used, along and close to the western shore of this part of the river for nearly one century.

For the year 1879-80 the Bellary bar was closed—

To vessels of 24 feet	43 days.
Ditto 23 „	14 do.
Ditto 22 „	5 do.

The average water reported on the Bellary bar since its use is 12 feet reduced to low water spring tides.

The depth of water on the James and Mary's Shoal will be found to vary in depth: on the 25th March 1869 the best track only had 8 feet 9 inches. In 1879-80 the detention to vessels was as follows:—

	Days.
Vessels of 24 feet	37
„ of 23 „	19
„ of 22 „	12
„ of 21 „	6
„ of 20 „	1

In my opinion, the river above Diamond Harbour has not deteriorated in depth during the last 28 years. In June 1863 I piloted down a vessel of 1,828 tons, drawing 23 feet 6 inches, though this was an unusual draught and size in those days.

What I have found a very serious obstacle to piloting the present steamers, 400 feet in length at a draught of 24 feet and somewhat over, and selecting the deepest water in the narrow reaches between Calcutta and Hooghly Point, especially between Calcutta and Budge-Budge, is the numerous native boats that are constantly in the way; were it not for steering by steam, accidents would be much more frequent, and the navigation would be more difficult.

In reply to last part of question No. 1, "What would be gained by terminating their voyage at Diamond Harbour?" vessels would escape those dangers above it, three and a half hours' saving of coal bound to Calcutta, and five hours bound from Calcutta, and according to the times of tide, depth of water in the channel, season of the year, one or more days in transit.

(2) Do vessels at present find it necessary or convenient to anchor in Diamond Harbour, and if so, for what reasons?

Messrs. Henderson & Co. say:—We understand ships only anchor when it is necessary to wait for the tide.

Messrs. Gladstone, Wylie & Co. say:—Inward-bound vessels find it sometimes necessary to anchor at Diamond Harbour to wait for the tide to get across the James and Mary's. Outward-bound vessels anchor at Kulpee, waiting for high water to cross the Bellary Bar.

Messrs Jardine, Skinner & Co. say:—Vessels are often neaped at Diamond Harbour, there being too little water for them to proceed over the James and Mary Shoal, and it is often availed of too when such good anchorage could not be gained elsewhere within daylight.

Captain Yates, Harbour Master, says:—Vessels anchor for various reasons: for want of daylight to proceed up or down, for rise of tide to cross the next bar, to ride an easier tide in the freshets (than at Kulpee) and on account of bad weather, as it is a less exposed anchorage than Kulpee.

Lieutenant Petley, R.N., River Surveyor, says:—On occasions it becomes necessary. Kulpee is more often used as an anchorage by vessels proceeding down, and Diamond Harbour by vessels coming up the river.

The reason for vessels anchoring in these recognised localities is either on account of their not having sufficient water on the bars for them to proceed either way, or on account of nightfall.

Lieutenant Stiffe, I.N., Port Officer, says:—Only for *tide* they generally anchor some miles below at Kulpee.

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* Midway between Mud Point and Diamond Harbour.

Some vessels have discharged or transhipped passengers there, but it is not a port at which anything is allowed to be landed or shipped.

Mr. Elson, Master Pilot, says:—Vessels generally anchor at Diamond Harbour on account of its being a safe anchorage in strong southerly winds which blow across the stream of both flood and ebb, so that vessels seldom foul their anchors whilst springing to the tide. The channel runs about east and west.

It is also the nearest anchorage below the James and Mary's, where vessels wait to cross that shoal.

Mr. Milner, Branch Pilot, says:—It is not actually necessary that any vessel should anchor at Diamond Harbour.

It is occasionally convenient for ships coming up in tow (as likewise those going down from Fisherman's Point) late on the neap tides to anchor here, so as to take advantage of the last of the flood tides in the morning.

Vessels also lie quieter here when it is blowing hard in south-west monsoon, with the wind abeam, than they would at Kulpee with the wind aft; and for this reason it is convenient for outward-bound ships, when the ebb tide will admit of their reaching Kulpee before the flood is in.

It is also a convenient place for weighing under sail in the south-west monsoon for proceeding up.

It would be dangerous for the long ships of the present day to be anchored in the slack at Diamond Harbour, as it would be necessary to give them plenty of swinging room, which would place them nearly on the line of eddy tide with the risk of tearing the windlass out of them, or parting the cable.

Large light steamers anchor here sometimes, and from mere custom, when a more intelligent discretion would have suggested the vicinity of Roychuck as being a far better position for turning in the morning to go up.

I have seen a Ducal steamer anchor below the Custom House at Diamond Harbour, the pilot being unable to turn her the next morning on the flood tide until he had drifted to Hospital Point. Had he anchored off Roychuck tree, he would have only had to turn her half round towards Hooghly Bight.

Mr. Grimley, Collector of Customs, says:—In consequence of the difficult navigation between Diamond Harbour and Calcutta, which is considered the most dangerous portion of the river, vessels frequently anchor at Diamond Harbour as a matter of necessity to await a rise of tide, in consequence of its being the safest and most convenient anchorage in the river.

Captain Thompson says:—A matter of convenience going down, necessary when coming up, if not able to cross the James and Mary's.

Mr. Daly, Branch Pilot, says:—Diamond Harbour has always been considered one of the safest anchorages in the Hooghly. Vessels are generally brought up there for safety when neaped or otherwise necessarily detained.

Messrs. Apcar & Co. say:—Vessels which have sailed up the river occasionally anchor at Diamond Harbour to wait for a tug to tow them up to Calcutta; it is also used as a half-way anchorage by vessels proceeding down the river during neap tides.

Messrs. Gillanders, Arbuthnot & Co. say:—Diamond Harbour is one of the places where vessels anchor in proceeding up and down the river waiting for a favourable tide.

The Committee of the Bengal Chamber of Commerce say:—Yes, for many reasons; as waiting for rise of tide, choice of anchorage, &c.

Mr. Joseph Richard Wells, Branch Pilot, says:—In 1879 I piloted 46 ships and steamers, and anchored at Diamond Harbour five times.

On quarter day it is high water at the James and Mary's a little before 6 A.M. Piloting up at this time of tide, by pushing for Diamond Harbour, a day is sometimes saved, for if you lose the morning tide, when the James and Mary's Bar is shallow, requiring high water to cross it, there is not sufficient daylight to attempt it in the evening. Under ordinary circumstances I do not care for Diamond Harbour anchorage; the slack which runs off the Custom House and above it affords but anchorage for a few vessels, and on weighing* as you have to turn on an ebb tide to meet the flood tide at Kulpee, you may find some difficulty in performing this if vessels come to an anchor in your vicinity after you have anchored your vessel.

(3) How many vessels can anchor with safety in Diamond Harbour?

Messrs. Gladstone, Wylie & Co. say:—As many as in Calcutta, or more.

Messrs. Jardine, Skinner & Co. say:—At present we are told 20 to 30; with proper moorings many more, it is said, could be provided for.

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* Bound out.

Captain Yates, Harbour Master, says :—A large number; a dozen vessels might be placed off Diamond Harbour without blocking the traffic.

Lieutenant Pelley, R.N., River Surveyor, says :—There is about 80 square acres of anchorage space of over 30 feet of water, at low water spring tides within the limits of the recognized anchorage. Then taking out about 40 square acres for navigating purposes, it would leave only 40 square acres for all classes of vessels to anchor in, which in river like the Hooghly, where the tides run in full strength during the strong floods in April, May, and June over seven knots, and in the freshets, *i.e.*, August, September and October, at the same strength, I would consider that each vessel should have at least one and half square acres to anchor in.

Lieutenant Stiffe, I.N., Port Officer, says :—Any number. It is not a harbour, but a reach of the river.

Mr. Elson, Master Pilot, says :—Allowing 300 yards between each vessel, ample swinging room at single anchor may be found between the western limits of Diamond Harbour, Buffalo and Hospital Points, and the eastern limit—Diamond Harbour or Chinghree Creek—for between 30 and 40 long vessels, and of course for more if they were to be moored with two anchors, and this should leave a wide channel for traffic, seeing the space available, with not less than five fathoms of water, is 2¾ miles in length by from ½ to 2¾ of a mile broad.

Mr. Milner, Branch Pilot, says :—This question is put rather vaguely. It does not state any limits, or whether a working channel should be left for ships navigating under sail beyond that place. For this purpose it would be necessary to allow considerable space, as the spring floods set strong on to the northern bank, and even vessels coming up in the south-west monsoon under sail would require considerable room for staying above the Custom House. Under these circumstances, I cannot give an approximate idea of how many vessels could be anchored with safety at Diamond Harbour.

Captain Thomson says :—About ten.

Mr. Daly, Branch Pilot, says :—I should say at least 30 at a rough guess, that is, leaving a navigable space for ships passing up and down.

Messrs. Apcar & Co. say :—During the freshets Diamond Harbour is not a safe anchorage unless very close in shore, and even then the vessel is liable to get into nasty eddies. At other times, when tides are not very strong, from 16 to 20 vessels may find anchorage space; but on the whole it is not a desirable anchorage, and vessels do not anchor there unless compelled to do so. Vessels prefer anchoring at Kulpee if possible.

Mr. Joseph Richard Wells, Branch Pilot, says :—I will first define what I consider the anchorage at Diamond Harbour is. I consider Diamond Harbour anchorage to be within the following limits:—From the Custom House bearing* E. ½ N., distance 400 yards from low water mark to the Telegraph House bearing N. E. by N., distance 400 yards from low water mark, joining these positions by a straight line measuring about 1½ miles. Allowing each vessel 900 feet, and anchoring them in a double row, about 18 to 20 vessels could be anchored here within the above limits, and would leave a navigable channel outside or to the southward of them.

Now as to the safety. During the south-west monsoon, when it blows hard, a considerable sea gets up off Diamond Harbour, so that no dâk boat can remain alongside. In May 1872 I was at anchor here several days and unable to communicate with the shore by boat owing to the hard monsoon and consequent sea: this was no gale, but a burst of strong southerly wind. Although I have answered the first part of the question as to the number of vessels there would be room for, I cannot say I should, were I interested in a ship, consider her particularly safe; not during the months of March to June, not until the monsoon had broken just before the rainy season sets in.

Were Diamond Harbour looked upon as a roadstead for ships to load in, the detention would be at certain seasons considerable, besides the charge of demurrage for cargo boats, and the damage to them owing to weather, would not establish Diamond Harbour as a favourable port to load at.

(4) Do you consider that long vessels are more difficult to navigate than short ones in the channels of the Hooghly?

Messrs. Gladstone, Wylie & Co. say :—The largest steamers now coming here have steam-steering gear, and there is no difficulty in managing them in any part of the river; with hand-steering long vessels are more difficult to handle than short ones, though some pilots think that the eddies have less influence on long than short vessels.

Messrs. Jardine, Skinner & Co. say :—Yes.

Captain Yates, Harbour Master, says :—Yes as a rule, but in some instances long modern vessels are more easily handled than short vessels of great depth and beam of inferior model. This class of vessel, however, is rarely met now.

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* Bearings magnetic.

Lieutenant Stiffe, I.N., Port Officer, says:—To some extent, but it has not, so far, been found a serious question. It was apprehended it would be so, but practically has not been found to be the case.

Mr. Elson, Master Pilot, says:—Long vessels are unquestionably more difficult to navigate in the upper, contracted, and sharply curving reaches of the river, and moreover it is difficult to find anchorage so as to provide proper swinging room with chain sufficient to hold them in safety, as the broadest part of the available space in any part of the river above Diamond Harbour is under 300 yards in breadth, so that it becomes imperative that long steamers have their steam up at the change of the tide, or to moor with two anchors in these places where they have been compelled by unforeseen circumstances to anchor in.

Generally speaking, all vessels do manage to avoid anchoring between Diamond Harbour and Garden Reach, which I attribute to the great power of ocean steamers, and to the fact that large unwieldly ships are towed by the steamers, so that they can successfully clear both Moyapore Flat and the James and Mary's when outward-bound. Of course when inward-bound, having the tidal wave with them, less or no difficulty is felt in this respect.

Another consideration why such long steamers as now frequent the port are navigated with such success is the use of steam-steering gear, which gives the pilot more assurance, as he is sure the helm can and will be put over when it is required at once.

Mr. Milner, Branch Pilot, says:—I certainly do, although some long steamers are easier to navigate when turned than small short ones owing to the former having steam-steering gear and the latter hand-gear.

Some large, long sailing vessels in tow are altogether easier jobs than some smaller, ill-modelled, square warehouses called ships.

Mr. Grimley, Collector of Customs, says:—There can be no doubt that a vessel of considerable length must be more difficult to handle and turn than one of lesser dimensions in the narrow channels of the Hooghly, which in some places are barely a vessel's length, and where the slightest hesitation or error of judgment on the part of the pilot, or a dilatory answer to the helm, on the part of the vessel, would result in certain disaster.

Captain Wilkinson, Superintendent, P. & O. Co., says:—400 feet is quite long enough for vessels passing beyond Diamond Harbour. Length unlimited below.

Captain Thompson says:—Most certainly I do.

Mr. Daly, Branch Pilot, says:—Short vessels are more easily twisted and turned about, but I have always found long vessels ride better at anchor.

Messrs. Duncan Brothers say:—Long vessels in tow of steamers are more difficult to navigate than short ones, but the improved steam-steering apparatus of the long and modern steamers makes them as easily controlled as a short one would be with the old steering gear.

Messrs. Apcar & Co. say:—Long vessels, we consider, are more difficult to navigate than short ones in the Hooghly.

Mr. Joseph Richard Wells, Branch Pilot, says:—Undoubtedly. The long steamers of the present day require the most unremitting attention in the narrow reaches between Calcutta and Fisherman's Point, a distance of 27 miles. A little too much helm would cause a grounding; added to this there are only two safe places to turn in this distance, *viz.*, at Budge-Budge and off Point Jelly.

(5) What is the greatest length of (1) steam-vessel and (2) sailing-vessel under ordinary control which it would be prudent to navigate in the channels of the Hooghly between the sea and Diamond Harbour and between Diamond Harbour and Calcutta?

Messrs. Gladstone, Wylie & Co. say:—Steamers about 420 feet are quite long enough for this river, and sailing ships at from 250 to 280 feet above Diamond Harbour. From Diamond Harbour to sea the length of a ship does not so much matter, as there are not so many bends in the river.

Messrs. Jardine, Skinner & Co. say:—Five hundred feet to Diamond Harbour, but only say 400 feet to Calcutta on account of the narrower reaches above Diamond Harbour.

Captain Yates, Harbour Master, says:—Steam vessels of 420 feet, and sailing vessels of 338 feet in length, have been safely navigated to and from Calcutta. From sea to Diamond Harbour 600 feet might be managed.

Lieutenant Petley, R.N., River Surveyor, says:—A vessel of any length could come up to Diamond Harbour. Above Diamond Harbour is a question for the pilots to reply to.

Lieutenant Stiffe, I.N., Port Officer, says:—I would not assign any limit.

Nor would I assign any limit in *a* and *b* under 600 feet if a second tug in the case of a sailing ship, and a tug in the case of a steamer were used, and the tugs were powerful enough. It is strange that large steamers go down this river *without* a tug. In the Thames they always have to take a tug.

Mr. Elson, Master Pilot, says :—In view of the fact that some of the curves or bends of the upper reaches are so sharp, as Sangral (off the bazar), where the bend is more than a quadrant, with less than 1,100 yards radius, Tarmakers, Fultah Reach and Point and Noorpore or Anchoring Creek, all nearly as bad. I think steam vessels of 400 feet in length is the farthest safe limit above Diamond Harbour, and that sailing ships of that length or considerably more under it should have two powerful tugs to twist them about whilst passing these spots; and, as before mentioned, consideration should be had to the fact of no safe place to be found for such long vessels to anchor in if circumstances compel them so to do.

Mr. Milner, Branch Pilot, says :—Steamers of 550 feet in length, and sailing ships of 350 feet between the sea and Diamond Harbour.

Steamers of 450 feet in length, and sailing ships of 300 feet between Diamond Harbour and Calcutta; but, although I would not hesitate piloting ships of this class, there may be pilots who would not perhaps feel themselves equal to the task, as all men's judgment, nerve power and abilities for this particular kind of work is not up to the same standard.

Mr. Grimley, Collector of Customs, says :—I consider it is inconvenient, if not exactly unsafe, to navigate a vessel of a greater length than 350 feet in the channels above Diamond Harbour during the freshets and spring tides, while vessels considerably over that length may be handled with comparative ease below Diamond Harbour.

Captain Wilkinson, Superintendent, P. & O. Co., says :—See above (answer 4).

Captain Thompson says :—Any size up to 5,000 tons between sea and Diamond Harbour: and between thence and Calcutta, steamers not over 400 feet and sailing vessels 320 feet in length.

Mr. Daly, Branch Pilot, says :—I should say the maximum for steamers ought not to be more than 400 feet, and for sailing ships 250 feet to Calcutta. Vessels that would stop at Diamond Harbour could be much longer—say ships 300 feet and steamers of 450 feet.

Messrs. Duncan Brothers say :—The greatest length of steam vessel now coming to Calcutta is 420 feet and of sailing ship 338 feet, and we know there was no difficulty experienced in navigating these vessels either above or below Diamond Harbour. The names are (1) S.S *Tower Hill*, and (2) ship *Cuba*. It is difficult to condescend upon a figure indicating the greatest length of vessels which it would be unsafe to navigate in any of the channels.

Messrs. Apcar & Co. say :—

(1) Steamers about 450 feet.

(2) Sailing vessels about 380 to 400 feet in tow of tug steamers between sea and Calcutta.

Mr. Joseph Richard Wells, Branch Pilot, says :—

*Sailing vessels, tons 1,800 and 300 feet long.
Steamers „ 3,000 „ 400 „

* Only when in tow of one or more tugs.

I do not consider the ship under control with a head wind unless she has one tug ahead and one alongside. A large vessel like that must, in my opinion, be towed not less than six knots to be under control.

The steamer must be full-powered, able to steam at least 12 knots, to steer by steam, and her machinery must be in perfect working order, so that in turning to anchor, or to proceed, the engines can be reversed or turned ahead immediately. Were it not so, vessels of the *City*, *Ducal*, P. and O., and B. I. S. N. and other lines, would not be possible to turn in Garden Reach. This part of my answer applies more particularly between Diamond Harbour and Calcutta.

From Diamond Harbour to sea, I am unable to state. The long steamers built to trade between America and England would not, I think, be so deep now as with a full Calcutta general cargo, and it must be borne in mind that, suppose Diamond Harbour instead of Calcutta was the port of the Hooghly, there still would remain 70 miles and over of pilotage, and what would be the practical result of vessels considerably longer and more tonnage than those now trading from Europe to Calcutta must, I fancy, be put to the test to come to any decision worth having.

(6) Recognizing the present tendency to increase greatly the length of all vessels, do you consider that they are as yet near to the greatest length which can safely be navigated above Diamond Harbour?

Messrs. Gladstone, Wylie & Co. say :—The longest vessels now trading here are about as long as can be safely navigated above Diamond Harbour.

Messrs. Jardine, Skinner & Co. say :—Yes, as one of about 420 feet has already been up. She had twin-screws which facilitated her navigation.

Captain Yates, Harbour Master, says :—I think the lengths in answer (5) should not be exceeded for navigation above Diamond Habour, or say 400 feet for steamers, 300 feet sailing vessels, in view of all the contingencies of navigation.

Lieutenant Stiffe, I. N., Port Officer, says:—No; we have them now increasing daily.

Mr. Elson, Master Pilot, says:—I believe there is still a tendency to increase greatly the length of all vessels, and, as I have before mentioned, I think the present class of vessels now coming to Calcutta are quite long enough to be safely navigated above Diamond Harbour.

Captain Wilkinson, Superintendent, P. & O. Co., says:—As above (answer 4).

Mr. Milner, Branch Pilot, says:—No. 5, I think, meets this question.

Captain Thompson says:—I consider that ships and steamers of larger dimensions than those that up to this time have come to Calcutta would be much safer at Diamond Harbour.

Mr. Daly, Branch Pilot, says:—I consider that some of the vessels, both steam and sailing, now being built are too long for the narrow parts of the Hooghly.

Messrs. Duncan Brothers say:—We do not consider that vessels have yet near reached the length which it would be dangerous to navigate above Diamond Harbour.

Messrs. Apcar & Co. say:—The steamer *Kaiser-i-Hind*, length 400 feet, and the steamer *Nottinghill*, length 420 feet, have been safely navigated up to Calcutta. Refer to reply to No. 5.

Mr. Inglis says:—The size of vessels visiting Calcutta, so far as steamers are concerned, is necessarily limited by the practicability of taking them through the Suez Canal as it at present exists. This excludes the possibility of the largest-sized vessels coming to Calcutta until the canal is enlarged in my opinion.

Mr. Joseph Richard Wells, Branch Pilot, says:—I think the dimensions given in reply to question 5 quite long enough to ensure safety; anything longer above Diamond Harbour would be attended with risk both in navigating as also risk to collision in passing one another in some very narrow part of the river.

(7) What is the deepest draft safe for a vessel up to Diamond Harbour and between Diamond Harbour and Calcutta?

Messrs. Gladstone, Wylie & Co. say:—About 26 feet has been safely piloted, but the draft would have to be regulated by the water on the various bars. At present there is less water on the Bellary and Jellingham bars than on the bars above Diamond Harbour.

Messrs. Jardine, Skinner & Co. say:—Twenty-six feet up to Diamond Harbour and 26 feet above it. Sometimes, say for a month or two in the year, it would be dangerous to bring a vessel drawing 26 feet over the "James and Mary."

Captain Yates, Harbour Master, says:—This is a question of season: in the rains the shoalest water is below Diamond Harbour, in the dry season above. Vessels exceeding 25 feet in draft from Calcutta are not infrequent.

Lieutenant Stiffe, I.N., Port Officer, says:—A vessel of 26 feet has been taken to sea from Calcutta, and I doubt not 27 might go at proper time of tide. The shoalest bars being below Diamond Harbour, no deeper vessel can go to that place than to Calcutta.

Mr. Elson, Master Pilot, says:—Looking to the present state of the river, I think 25 feet below and 23 or 24 feet above Diamond Harbour should be the limit of draft of vessels, consideration being always had to the seasons of the year, when the general level of the water-surface is higher or lower, and to the changes which are always taking place in the channels. It must be always remembered that a vessel can go up the river easier with the tidal wave than come down against it, and therefore will be able to go up deeper in draft than to come down.

Mr. Milner, Branch Pilot, says:—Twenty-six feet between both places. Vessels between 25 and 26 feet are occasionally piloted from Calcutta to sea. There is no deeper anchorage to be found in the Dredge and at Saugor than there is above the James and Mary's, and for this reason I confine the draft to 26 feet below Diamond Harbour; a deep steamer cannot always depend on getting from Kulpee to Saugor.

Captain Thompson says:—24 feet to and from Calcutta and 25 to Diamond Harbour, according to moon and season. Best water in September, October, and November.

Mr. Daly, Branch Pilot, says:—It depends upon the seasons entirely. During the freshets a steamer has been known to go down drawing 25 feet 6 inches, and a sailing vessel at 25 feet, but at this draft the greatest caution is necessary.

Messrs. Duncan Brothers say:—Owing to changes in the bed of the Hooghly, we believe there is at present less water in one of the channels (Bellary we think) below Diamond Harbour than in any above that anchorage. The deepest draft might be ascertained from records of Port Commissioners, but, so far as we can remember, the greatest draft we have heard of in the Hooghly was the *Hooper* telegraph boat, and the draft was given as 26 feet.

Messrs. Apcar & Co. say:—At certain times of tides vessels of 26 feet draft water could with safety be navigated both to Diamond Harbour and to Calcutta.

Mr. Inglis says:—The same remark applies to draft, which cannot exceed the draft of vessels passing through the Suez Canal, say 26 feet.

Mr. Joseph Richard Wells, Branch Pilot, says :—The first and second both depend upon the state of the channels in each of these sections, divided under two heads in the question; *vide* statements, page 2, sheet 242, Gasper; and pages 2 and 3, sheet No. 3, Bellary and James and Mary's.

(8) If the depth and length of vessels were not kept in check by the difficulties of navigation in the Hooghly, is it likely that these dimensions in vessels would increase (1) in case of sail; (2) in case of steam, regard being had to the limit imposed by the Suez Canal ?

Messrs. Mackinnon, Mackenzie & Co. say :—We think the Hooghly might receive any vessel the canal, as presently existing, could pass.

Messrs. Henderson, & Co. say :—Experience shows that almost the largest vessels of the Mercantile Marine can visit Calcutta with safety.

Messrs. Gladstone, Wylie & Co. say :—The extreme draft allowed in the Suez Canal is 24 feet 7 inches, so that steamers are not likely to be built for this trade to draw more water than they do now; nor do we think that they are likely to be built of greater length than at present. The tonnage may be increased by adding to the beam. Sailing ships are also as long as we think they are likely to be.

Messrs. Jardine, Skinner & Co. say :—We do not think that, if the difficulties of navigating the Hooghly were overcome, we would have a class of vessels drawing over 26 feet.

Captain Yates, Harbour Master, says :—I cannot say, but the Suez Canal, limit of depth 26 feet, has been reached outwards from Calcutta.

Lieutenant Stiffe, I.N., Port Officer, says :—1. No.

2. No; we already can go to the extent of the Suez Canal, and the increase of dimensions tends rather to length and breadth than to depth.

Mr. Milner, Branch Pilot, says :—I doubt whether the difficulties of navigation in the Hooghly have had any material influence in checking the depth and length of vessels. It is the general remark of commanders that the largest and finest fleet of ships in the world is to be found in the port of Calcutta. The present tendency seems, however, to build both ships and steamers of much larger size by giving vessels much more beam, and where an owner carried three cargoes, he finds it more profitable to carry the same amount in one hull, as he only pays and feeds one commander, one crew, pilotage once, &c., instead of for three vessels.

Captain Wilkinson, Superintendent, P. & O. Co., says :—Yes, as regards steam vessels, ships can pass through the Suez Canal at 26 feet. There are one or two curves in the canal that might cause a limit to length, but these might be greatly reduced, if found necessary, by cutting away the convex bank.

Captain Thompson says :—Yes, most likely, both in sailing and steam vessels.

Mr. Daly, Branch Pilot, says :—Of late years the Hooghly has been very little studied by owners and builders, and were it not for the unrivalled skill of the present pilots, I fancy much more difficulty would be experienced by the large class of steamer and ship now frequenting the port. The Suez Canal is obliged to be studied on account of some of its narrow curves.

Messrs. Duncan Brothers say :—That the length and depth of vessels are kept in check by the difficulties of navigation in the Hooghly is questionable. We believe that if a steamer passes through the Suez Canal with safety (her draft and length being up to the canal limit), she may with equal safety be brought to Calcutta.

Messrs. Apcar & Co. say :—The tendency is to increase the size of steamers owing to less proportionate expenses of a larger vessel.

Messrs. Gillanders, Arbuthnot & Co. say :—The dimensions of both sailing and steam vessels have largely increased in recent years, and it is probable that the proportion of large vessels will further increase.

The Committee of the Bengal Chamber of Commerce say :—Probably.

(9) Are there any other points in connection with the navigation of the Hooghly which you can suggest to the Committee as affecting the question of docks at Diamond Harbour, either for or against the scheme ?

Messrs. Henderson & Co. say :—With an efficient and well-paid Pilot Service the river risk appears to be very small, as is proved by the case that no extra rate of insurance is charged for the Hooghly risk.

Messrs. Gladstone, Wylie & Co. say :—With full-powered steamers having steam-steering gear and careful piloting, there is no necessity for stopping at Diamond Harbour. The same applies to sailing ships in tow of powerful tugs. There is of course some chance of the danger of the river increasing at times by the channels getting shallower, but that is as likely below Diamond Harbour as above.

Messrs. Jardine, Skinner & Co. say:—We think the Calcutta trade is not great enough yet to require accommodation at Diamond Harbour as well as at the Port proper. We understand there are doubts as to vessels being able to lie close into the bank at Diamond Harbour except below the Custom House, and that the locality is unhealthy, and we believe the expense of carrying out the proposed Diamond Harbour scheme would be so great that the trade which would go there would for many years not be able to bear the interest on the outlay.

Captain Yates, Harbour Master, says:—The proposed dock entrance at Diamond Harbour is on a dead lee-shore during south-west monsoon, in which season, say April to August inclusive, the wind blows half a gale, which would be a difficulty in the way of docking and undocking vessels. A steam vessel starting from Saugor or sea on the first of a spring tide can get to Calcutta at high water same tide.

Lieutenant Petley, River Surveyor, says:—I consider that making docks at Diamond Harbour have these serious disadvantages—

1st.—The anchorage space is *limited*, and therefore a number of vessels anchored off the docks would materially interfere with the navigation of the river for vessels proceeding to or from Calcutta.

2nd.—The sea at Diamond Harbour during the strength of the south-west monsoon would, I consider, debar the operations of docking and undocking the vessels, for if the gates are to be placed (as I am given to understand) just inside the left bank of the creek, it will be a *dead lee-shore*, and the slightest hitch in the handling of the ship, or the breaking of a hawser, would most certainly throw the vessel againt the dock wall; perhaps wreck her altogether.

3rd.—Vessels could not at any time of the year be safely docked or undocked except at slack tide, and during the freshets the duration of slack water is so very short, there would certainly not be time to dock or undock more than about three vessels.

Lieutenant Stiffe, I.N., Port Officer, says:—There is the question of vessels leaving Calcutta during the freshets, which involves a certain risk, especially at springs, when large vessels have to leave and anchor anywhere above Hooghly Point.

I suggest a reference to the medical authorities. I believe it is a hot-bed of fever.

Further no doubt, although *apparently* not detained, yet the largest class of vessels *do* wait for springs to start to some extent.

Mr. Milner, Branch Pilot, says:—Diamond Harbour Creek appears to me to be a most unsuitable position for docking vessels in the south-west monsoon, being dead to leeward and open to the full force of the spring tides and strength of the monsoon.

More difficulty, I apprehend, would be experienced in putting vessels into dock than in taking them out, and it seems probable that vessels would require two tugs to manœuvre them in the creek, as I understand the dock gates are to be a little above the position of the Magistrate's house, which would entail expense.

Some brick ruins may be observed on the western lip of the creek, which, in 1851, was the post office, then situated some distance in shore. This is evidence of the washing away of the bank in this vicinity, and as there is deep water along it, both above and below the creek, it seems probable that there would be great engineering difficulties in preventing the bank from being further cut away.

The dock board should also be prepared to undertake the towage of vessels, for if ships are to be relieved from much of this expense by their sailing up to Diamond Harbour in the south-west monsoon, and having so much less steam down, it means so much less inducement for investing in steam-tug property, especially as they are said not to pay under present circumstances, and it would always be necessary to have powerful tugs to tow, more especially the increasing size of ship to sea in the south-west monsoon.

The dock and accessories are estimated to cost one million sterling. On this capital sum a return interest of 4 per cent. would be required, I presume which, reckoning the cost of exchange, would amount in round numbers to a charge on ships of R40,000 a month. But I think that Indian estimates may generally be multiplied by two, which would mean a charge of R80,000 a month as dock-hire on ships.

Would any eminent firm of contractors guarantee the completion of the work for one million sterling?

I am also of opinion that, if the docks were constructed, there would be much difficulty and expense in keeping them free from silt; that they would not be a financial success; that charges on shipping would not be so reduced as to compare favourably with other ports; that if a commodious and safe port can be found contiguous to Calcutta, easy of access and egress to the sea, where vessels of the largest size could navigate, where charges could possibly be reduced to a minimum so as to compare favourably with any other port; that this place should be adopted in preference to the Diamond Harbour scheme.

I allude to the Mutlah River, below the Cuttalee, and from point Beadon to the Bidds River.

Captain Thompson says:—The railway expenses for conveying goods would fall rather heavy on the vessels. I see nothing else against the scheme.

Mr. Daly, Branch Pilot, says:—When I came to India 33 years ago, the post office at Diamond Harbour was some distance from the river. It has been gradually washed away (a pucca building). Diamond Harbour is a dead lee-shore in the south-west monsoon, and one of the great difficulties against making a dock there, I fancy, will be silt. I have always thought Diamond Harbour ought to be an auxiliary port, especially for small vessels which are unable to afford the heavy expenses of steam-hire. It might be especially a port for loading grain.

Messrs. Duncan Brothers say:—There is one point in favour of the scheme, *viz.*, that vessels and steamers would be able to leave Diamond Harbour during the freshets (the river being wider below there) almost at any stage of spring tides, while they are detained in town till the neap tides in the freshet season owing to the river being narrower above Diamond Harbour, and the current stronger and consequently more dangerous.

Messrs. Apcar & Co. say:—No.

Mr. Inglis says:—The entrance to the docks at Diamond Harbour would be so exposed during the south-west monsoon that I think it is a most unsuitable place for the scheme.

The Committee of the Bengal Chamber of Commerce say:—*For*—In the freshet season there would be a special advantage to a vessel commencing her voyage at Diamond Harbour.

Against—The fact of proposed site being on a lee-shore in a locality exposed to violent winds requires very serious consideration.

Mr. Joseph Richard Wells, Branch Pilot, says:—I have endeavoured to show the risk to vessels and their detention in the event of the Gasper Channel shoaling and becoming narrower.

I have stated what the depth was in 1853-54; is there any proof forthcoming that it will not re-occur? If there is not, would it be judicious to expend one million sterling in constructing docks at Diamond Harbour for the present class of vessels whose size and length is on the increase rather than otherwise, and whose draught of water, if it did not much exceed what it is at present, is not likely to diminish much, without some more tangible proof than at present exists that the navigation of the Hooghly from sea to Diamond Harbour can be guaranteed to remain in as good a state as it is at present.

Even if docks were established at Diamond Harbour, there would be many days during the south-west monsoons when docking and undocking would, in my opinion, be impossible owing to the heavy weather experienced at Diamond Harbour at certain seasons of the year, especially during the months of March to June.

No ordinary structure would prevent the docks from being entirely submerged if a rise of tide, such as was experienced there on the 5th October 1864, happened again. Much of the land to the northward of Diamond Harbour would have to be reclaimed to ensure the sanitary condition as a port, especially during the rainy season and early part of the north-east monsoon. Abundant proof will, I think, be found of the necessity of this from the sick returns of the Custom House officers, who at one time were stationed here for the purpose of boarding inward-bound vessels.

(10) Having in view the probable increase of traffic on the Calcutta side of the river on the completion of the Railway Bridge over the Hooghly, do you think that the space now at the disposal of the Port Commissioners will be sufficient for wharfage and general accommodation?

Messrs. Mackinnon, Mackenzie & Co. say:—We think the space at the disposal of the Port Commissioners would admit of arrangements for a proper handling of a largely increased tonnage.

Messrs. Henderson & Co. say:—We think not, unless space is economised.

Messrs. Gladstone, Wylie & Co. say:—As it is barely sufficient at present at all times, it will be less so when the bridge is completed.

Messrs. Ralli Brothers say:—The present space at the disposal of the Port Commissioners will not be quite sufficient for wharage, but there is ample room in the port for vessels to load in the stream.

Messrs. Prankissen Law & Co. say:—We do not think the space at the disposal of the Port Commissioners will be sufficient if the whole of the Howrah traffic is diverted to Calcutta, but such it appears to us is not likely to occur for some considerable time to come. We, however, know nothing certain about the plan of the East Indian Railway Company in connection with the Hooghly Bridge, and are therefore unable to form any definite opinion on the question of accommodation in Calcutta.

Messrs. Jardine, Skinner & Co. say:—It will be sufficient for a time, but not for very long.

Mr. Scott, Vice-Chairman of Port Commissioners, says:—No.

Captain Yates, Harbour Master, says:—If the Railway Bridge and its traffic increases the demand for wharfage, &c., an extension of the jetties to Baboo Ghât should meet it.

Lieutenant Stiffe, I.N., Port Officer, says:—No; not unless the bank above the bridge is at their disposal.

Mr. Milner, Branch Pilot, says:—As the tendency appears to be in favour of vessels of large tonnage to the decrease of numbers, I am of opinion that the space available in the port of Calcutta will be sufficient for wharfage and general accommodation.

Mr. Grimley, Collector of Customs, says:—When the Railway Bridge over the Hooghly is completed, and direct communication established between the producing districts of the North-West Provinces, Eastern and South-Eastern Bengal, and Calcutta, it seems to be beyond doubt that the accommodation at present at the disposal of the Port Commissioners at Calcutta will be inadequate for the traffic, as immense quantities of produce, which are at present water-borne, either direct from the producing districts, or from the Howrah and Chitpore termini of the East Indian and Eastern Bengal Railways, would then be diverted to the Railways for conveyance direct to the jetties for shipment. The increased facilities the Railways will afford, the decrease in expenditure which it would admit of, coupled with the advantage of the reduction to a minimum of wear and tear to packages, and loss and damage to goods by frequent handling and shifting, may be expected to produce a marked increase on the traffic to the jetties.

Captain Wilkinson, Superintendent, P. & O. Co., says:—No; vessels have now very often to wait two or three days for a berth at the jetties.

Captain Thompson says:—No.

Mr. Prestage says:—I do not; more particularly if the Bridge be built where it should be, as near as possible to Calcutta, to also serve the proposed Calcutta and Bombay direct railway *viâ* Midnapore and other connected railways that will in time be made to the south-west of Calcutta.

Mr. Daly, Branch Pilot, says:—There would be plenty of space for years to come if you will move the Hooghly Bridge higher up.

Messrs. Duncan Brothers say:—No.

Messrs. Apcar & Co. say:—No. It will not be sufficient.

Mr. Inglis says:—I think much might be done to increase and improve the accommodation on the Calcutta side by extending the jetties southward, and as much accommodation as we now have on the Calcutta side might be obtained on the Howrah side by adopting proper reclamation works. The most should be made of our present space before any expensive works are undertaken elsewhere.

Messrs. Gillanders, Arbuthnot & Co. say:—The space provided in Calcutta by the Port Commissioners for wharfage is already, we consider, insufficient when a large number of vessels are in port, and having in view the probable further increase in the trade of Calcutta, more accommodation is likely to be necessary.

The Committee of the Bengal Chamber of Commerce say:—The Committee think not.

(11) If not, can you suggest any means of supplying the deficiency of space otherwise than by constructing the proposed docks?

Messrs. Hoare, Miller & Co. say:—The great bulk of the general cargo brought into the port is required for delivery in the town of Calcutta. It seems to us that the best general design for the arrangement of the port is one that would provide landing facilities on the Calcutta side of the river, and shipping facilities on the Howrah side of the river.

Messrs. Henderson & Co. say:—Economise space and, when necessary, extend jetties to or below Fort Point.

Messrs. Gladstone, Wylie & Co. say:—Increase the accommodation for exporting by cargo-boats, which is too limited at present; add one more jetty for imports if required.

Messrs. Ralli Brothers say:—In case of difficiency of space for wharfage, the Port Commissioners may acquire further space of land on the Calcutta side of the river within the port, say at Garden Reach, where docks and jetties to be connected by railway can be more conveniently built than at Diamond Harbour.

Messrs. Jardine, Skinner & Co. say:—Yes, by taking up land at Garden Reach and buying out the ex-King of Oudh. We are informed that from a little below Bishop's College to Pansparìah below Garden Reach, both sides of the river are deep, and if so, ample accommodation might be provided.

Mr. Scott, Vice-Chairman of Port Commissioners, says:—Jetties might be erected as far as Baboo Ghât or Outram Road, and the foreshore reclaimed.

The whole of Garden Reach is suitable for jetties or wet docks.

Captain Yates, Harbour Master, says:—Wet docks in the vicinity of Calcutta.

Lieutenant Stiffe, I. N., Port Officer, says:—Yes, by having jetties on the Howrah side and embanking it. It would be a great advantage to have the river from the bridge to Shalimar Point brought to an uniform width and curve of channel.

Mr. Grimley, Collector of Customs, says:—The only way possible to provide for the deficiency in the present accommodation of the jetties will be by the erection of a larger number of warehouses, sheds, and increased jetty accommodation; but I believe that almost all the available portion of the Strand Bank below the bridge that could be taken up for such a purpose has already been utilized, and any further extension would be undesirable, as it would interfere with the health and appearance of the city, while the construction of any such requirements above the present pontoon bridge would not be convenient.

Captain Wilkinson, Superintendent, P. & O. Co., says:—Land might be reclaimed beyond the boundary of the present roadway from Chandpal Ghât and Fort Point and jetties erected, but no doubt this would be objected to by the general public.

Captain Thompson says:—The docks at Diamond Harbour most advisable.

Mr. Prestage says:—Whether the proposed wet docks are constructed or not, it is, I think, well worthy of consideration whether more jetties should not be constructed at Garden Reach and connected with Calcutta, the existing and the proposed railways, by a suburban railway, as shown in the accompanying sketch map.

Mr. Daly, Branch Pilot, says:—Remove the bridge and you ought to have ample space.

Messrs. Duncan Brothers say:—No.

Messrs. Apcar & Co. say:—The jetties could be extended from the point where they now terminate to Cambabatelus Point in Garden Reach, leaving below that room for vessels to turn when proceeding down the river. This is presuming that the jetties, warehouses, &c., will be allowed to be built opposite the Fort.

Mr. Inglis says:—Wet docks might be constructed at Garden Reach and connected by rail with the several railway systems, and if at any future time the navigation of the Hooghly becomes more difficult than it is at present, a ship canal from the Mutlah to Garden Reach and the docks there would be a far better scheme than the proposed docks. The great drawback to the Diamond Harbour scheme, besides that mentioned in my answer to question 9, is that it does not get over the difficulties of the Hooghly below that point. Sometimes I understand they are greater below Diamond Harbour than they are above.

Messrs. Gillanders, Arbuthnot & Co. say:—It appears to us that the mooring jetties might be extended, and that it should besides be practicable to arrange further additional accommodation for shipping within the limits of the port. We would instance the site of the Eden Gardens and vicinity, which appears well adapted for dock purposes, and there seem to be other suitable sites.

The Committee of the Bengal Chamber of Commerce say:—Much may be done, as by removing the Hooghly Bridge to a position further up the river by extending the jetties north up to Nimtollâh or thereabouts, and south to Garden Reach, with or without a break, abreast of the Fort and Gardens, &c. The Committee, however, quite think that docks offer many most important advantages over any other scheme, but they are not, without further enquiry, prepared to advocate their construction at Diamond Harbour.

(12) Can you give approximately the items of cost (distinguishing between those below and those above Diamond Harbour) incurred in bringing a steam vessel, say of 3,000 tons gross register, carrying 3,700 tons of cargo and drawing over 23 feet of water in the port, discharging her either (1) in the river, or (2) at the jetties, and conveying the goods to (1) warehouses, or (2) to the rails for despatch up the country, including all dues, pilotage, boats, carts, &c.?

Messrs. Gladstone, Wylie & Co. say:—The only difference between discharging at Diamond Harbour and Calcutta would be in the pilotage, as, at whatever place the steamer discharged, she would have to pay for stevedoring about four annas per ton at the jetties, and about one or one-and-a-half annas more if into boats in the river. The vessel pays no charge for warehousing the cargo, nor for despatch up-country. She is done with the goods as soon as they are over the ship's side, while at Diamond Harbour the intention seems to be to fix all liability for the goods on the ship till they are placed in consignee's hands, which is a risk that shipowners are not likely to accept.

	R	*a.*	*p.*
The pilotage of a steamer drawing 24 feet is from sea to Calcutta	558	0	0
From sea to Diamond Harbour	372	0	0
Difference	186	0	0
Pilotage of a sailing vessel in tow of a steamer drawing, say, 22 feet from sea to Calcutta	470	0	0
From sea to Diamond Harbour	313	6	0
TOTAL	156	10	0
Difference in towage	300	0	0

A sailing vessel of 1,000 to 1,600 tons would thus save about R456-10 by not coming higher than Diamond Harbour.

Mr. Simmons, Secretary to Port Commissioners, says:—The following statement gives the charges for bringing such a vessel as that indicated from sea to Calcutta, and discharging her at the jetties, but exclusive of the amount paid to stevedores for breaking out and slinging cargo in the hold with which this office has no experience. The only distinction between such charges as below and above Diamond Harbour would be in pilotage, which would be 25 per cent. less than that charged to Calcutta :—

"City of Khios," 3,246 tons gross register, draft 22 feet, inward.

INWARD.

	R	
Pilotage	470	
Lead money	16	
Port dues	398	
Hospital dues	133	
Harbour Master's fees	57	
Mooring hire	195	For the whole time discharging and loading.
Jetty charges	385	

24 feet.

OUTWARD.

Pilotage	614	
Lead money	16	
Harbour Master's fees	57	
Mooring hire	...	*See* above account.
Jetty charges	...	

Lieutenant Stiffe, I.N., Port Officer, says:—The Commissioners for effecting improvements in the Port of Calcutta can answer this. I append a schedule of pilotage charges.

Mr. Milner, Branch Pilot, says:—

	R	*a.*	*p.*
Pilotage to above Diamond Harbour telegraph station	383	8	0
Pilotage to Calcutta	510	0	0

It would be necessary for a large steamer coming up on the flood to go above Diamond Harbour telegraph station to turn.

Messrs. Duncan Brothers say:—

			To Diamond Harbour. R		To Town. R
	Pilotage	8-12th	340	12-12th	510
	Port and Hospital dues[1]		500		500
1	Discharging at moorings—				
	14 days' hire at R9 per day				126
	Boat hire on 3,700 tons				3,700
	Cart and cooly hire on 3,700 tons at R1-8 per ton				5,550
2	Discharging at jetty seven days—				
	R35 per day jetty hire plus mooring				245
	Cart and cooly hire on 3,700 tons at R1-8 per ton				5,550

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[1] A steamer of 3,000 tons *gross* would be, say, 2,000 tons net register; port dues are levied on the *net* register tonnage

Messrs. Apcar & Co. say:—The extra cost of bringing a steamer up to Calcutta instead of anchoring at Diamond Harbour would be—

(1) Difference of pilotage, which information the Port Commissioners would give more exactly.

(2) Extra cost of, say, 6 hours' coal, from ₹75 to ₹100.

(3) The expenses of discharging the cargo in the river of Calcutta or the jetties would be the same to the steamer, as she would pay the stevedore a fixed rate per ton for discharging the cargo. We do not know what the difference would be to the consignees of the goods, whether they received their cargo from the steamer into boats, or if it were landed at the jetties. Boat hire at times varies very considerably, and would entirely affect the cost.

The Committee of the Bengal Chamber of Commerce say:—The cost of putting out cargo is paid by the vessel and amounts to from 4 to 6 annas per ton.

(13) Can you give the same charges with the addition of towage for a sailing vessel 1,600 tons register, carrying 2,400 tons of cargo and drawing over 21 feet of water?

Messrs. Gladstone, Wylie & Co. say:—No charges for warehousing and despatching are payable by the ship, whose responsibility ceases as soon as the goods are free from ship's tackles.

Mr. Simmons, Secretary to Port Commissioners, says:—Ship *Argonaut*, 1,563 tons gross—

Draft 21 feet inward.

	₹	
Pilotage	430	
Lead money	16	
Port dues	279	
Hospital dues	93	
Harbour Master's fees	57	
Mooring hire	105	Covers loading and discharging.
Jetty charges	350	
Towage regulated by demand, say two days at ₹500	1,000	

Draft 21 feet outward.

Pilotage	478
Lead money	16
Harbour Master's fees	57
Towage, say 2½ days	1,250

Lieutenant Stiffe, I.N., Port Officer, says:—The towage up varies from ₹1,000 to ₹1,800 according to the demand for tugs at the Sandheads.

Mr. Milner, Branch Pilot, says:—

	R	*a.*	*p.*
Pilotage at 22 feet from sea to Calcutta, using steam from Saugor ($\frac{8}{12}$)	521	14	0
Towage from Saugor	900	0	0
Total	1,421	14	0
Pilotage at 22 feet from sea to above Diamond Harbour telegraph station, using steam from Saugor	405	0	0
Towage from Saugor to Diamond Harbour	450	0	0
Total	855	0	0

Messrs. Duncan Brothers say:—

		To Diamond Harbour.				To Town.		
		R	*a.*	*p.*		*R*	*a.*	*p.*
	Pilotage, $\frac{5}{12}$ths	288	8	0	$\frac{12}{12}$ths	431	4	0
	Towage	700	0	0		500	0	0
	Port and hospital dues					400	0	0
1	Discharging at mooring, 14 days, at ₹7 per day					98	0	0
	Boat hire on 2,400 tons					2,400	0	0
	Cart and cooly hire					3,600	0	0
2	Jetty hire, eight days, at ₹35 plus mooring hire at ₹7					336	0	0
	Cart and cooly hire					3,600	0	0

Messrs. Apcar & Co. say:—The extra charge to a ship would be extra towage, say ₹600, and extra pilotage.

The Committee of the Bengal Chamber of Commerce say:—The charges on cargo will be much the same in case of sailing vessels as in that of steamers—say R1-8 to R2 per ton.

(14) Can you give similar particulars with respect to loading such vessels and despatching them to sea?

Messrs. Gladstone, Wylie & Co. say:—The ship has nothing to pay for the cargo going on board, and has no responsibility regarding the goods till they are received on board.

Messrs. Jardine, Skinner & Co. say:—The steamer *Adjutant*, of 1,478 tons net register, entered at the Custom House on 30th January, and cleared on 4th February 1882.

Gross tonnage 2,275

		R	a.	p.
Had the steamer not come higher than Diamond Harbour she would have saved R83-11 inward and R119-8-6 outward pilotage.	Inward pilotage on 18 ft. 3 in. draft	335	4	0
	Outward ditto 21 „	478	8	0
	Port dues	277	2	0
	Hospital dues	92	6	0
	Mooring hire	84	0	0
	Transporting inwards and outwards	50	0	0
	Hauling into and from moorings	32	0	0
	Extra fees for night work	48	0	0
	Diver's charge for clearing away hawser . . .	50	0	0
	Jetty charges	280	0	0
	Overtime fees	142	4	0
	Crane hire	40	0	0
	Sunday charge for bill	24	12	0
	TOTAL . . .	1,934	4	0

Mr. Simmons, Secretary to Port Commissioners, says:—See answers to two foregoing queries.

Lieutenant Stiffe, I.N., Port Officer, says:—Towage down is at R600 per diem; two days may be taken as an average passage out, or three days if over 24 feet draft.

Messrs. Duncan Brothers say:—The charges on out-going vessels would be on the same basis as the foregoing.

Messrs. Apcar & Co. say:—Replies to Nos. 12 and 13 may apply to this.

(15) Do you consider that there would be any gain in time or other advantages in working vessels lying in a dock and beyond the influence of the rise and fall of the tide?

Messrs. Steel and Co. say:—About two days,[1] provided the machinery could be examined in the shorter time.

Messrs. Mackinnon, Mackenzie & Co. say:—No.

Messrs. Gladstone, Wylie & Co. say:—There would be little more advantage in working in a dock than at the present jetties. The rise and fall of tide makes very little difference in loading or discharging ships, though sometimes at high water there is a little difficulty in high tides when the ship is nearly empty and lies high above the jetty. But this difficulty would probably also arise as the ship was emptied lying in a dock.

Messrs. Jardine, Skinner & Co. say:—No.

Captain Yates, Harbour Master, says:—Have no personal experience in this matter, but assume there would be a gain in convenience, though not in time, in a dock; the alterations of tide do not stop work or retard it, as far as I know, at the jetties.

Lieutenant Stiffe, I.N., Port Officer, says:—I have not much actual experience, but I should say it could be done as fast at the jetties as in a dock.

Mr. Milner, Branch Pilot, says:—Vessels would not lose time in consequence of cargo-boats being delayed by tide, &c.

Mr. Grimley, Collector of Customs, says:—Tidal influence is not a matter of much importance, although a contrary tide will certainly retard the progress of goods water-borne to a vessel loading in the stream, and to some extent delay her working, while the long hours of ebb would every moment lengthen the hoist and drop for vessels discharging or loading at the jetty cranes, which would represent a loss of time. I cannot, however, understand how it is intended to secure the proposed dock from tidal influence, for if it is anticipated that the docks will be extensively used, the lock-gates would require to be frequently opened, as occasion required, to receive or discharge a vessel, and as a natural consequence water would find its level.

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[1] Verbally by Mr. Steel to Colonel Trevor.

Captain Wilkinson, Superintendent, P. & O. Co., says:—There would be no difference in time between working in a dock or at jetties. A steamer could discharge quicker in the stream than alongside a wharf, as she could then work both sides.

Captain Thompson says:—A gain in time no doubt.

Mr. Daly, Branch Pilot, says:—I should say there would be considerable gain.

Messrs. Duncan Brothers say:—The rise and fall of the tide does not to any appreciable degree interfere with loading and discharge of vessels moored, or at the jetty in town.

Messrs. Apcar & Co. say:—If vessels are discharging into cargo-boats, none whatever, as the ship and cargo-boat would both rise and fall with the tide. If alongside the jetties, when the tide is low, there would be more hoist, when the tide is high there would be less hoist, so what would be lost at low tides would be gained at the high tide.

Mr. Inglis says:—I do not think there would be any appreciable gain by working vessels in dock.

Messrs. Gillanders, Arbuthnot & Co. say:—Vessels could be discharged and loaded more rapidly in docks provided with suitable warehouses, and there would be a saving of time and expense if ships bringing salt could discharge their cargoes directly into bonded golahs.

The Committee of the Bengal Chamber of Commerce say:—Yes, great advantages, but not chiefly dependent upon absence of rise and fall, though no doubt this will facilitate work. The benefits which a dock is calculated to bestow are principally (1) that goods can at once be landed without waiting for boats, &c., and by simple expedients, independently of weather; (2) that dutiable goods, as salt, can be put straight into bonded warehouse and delivered thence; (3) that produce can be stored prior to a vessel's arrival; (4) that stevedores' men, &c., can be kept under discipline, and the most work got out of them; (5) that obvious arrangements can be made for working day and night; (6) the efficient protection to the revenue which well-organised "closed" docks afford, and the consequent relaxation of customs supervision of loading and discharging which becomes possible, whereby considerable delays and expenses may be avoided; (7) generally that a ship on dock can be discharged and loaded as fast as the mechanical operations can be performed with the aid of powerful steam or hydraulic appliances.

(16) Apart from the time occupied in discharging and re-loading a steamer, what is the average time required for overhauling the engines and machinery?

Messrs. Hoare, Miller & Co. say:—A week to ten days suffices for a well found steamer. All that ought to require to be done ought to be practicable within a week.

Messrs. Mackinnon, Mackenzie & Co. say:—Ordinary overhaul week to ten days.

Messrs. Henderson & Co. say:—We think examination and petty repairs of machinery can always be done in less time than is occupied in unloading and loading.

Messrs. Gladstone, Wylie & Co. say:—Except in cases of accident or breakdown of machinery, the overhaul can be regulated by the time the steamer is to be in port. Machinery in good working order does not require much overhaul here.

Messrs. Jardine, Skinner & Co. say:—Engines and machinery can, as a rule, be overhauled in the time in which discharging and loading is going on.

Captain Yates, Harbour Master, says:—Ordinary overhaul of engines is done in this port while loading and discharging are going on.

Lieutenant Stiffe, I.N., Port Officer, says:—I do not think any steamer (except for accidents) is detained here on account of her machinery. Ordinary overhaul.

Mr. Grimley, Collector of Customs, says:—The time necessary to overhaul the engines and machinery of a steam vessel would depend in a great measure on the amount of examination and overhauling necessary; a set of new engines, for instance, would need a great deal more of examination than engines that had worked for any time. I, however, fail to notice how the use of the proposed docks will affect this question.

Captain Wilkinson, Superintendent, P. & O. Co., says:—This would depend greatly on the state of the engines; if a steamer left England in good order, and had no accident to her machinery during the voyage, twelve days would be ample.

Captain Thompson says:—This depends upon circumstances, but can generally be done during the time of discharging and loading.

Messrs. Duncan Brothers say:—The overhauling of engines and machinery might be done on an average within ten days, and is generally completed before the steamer has finished re-loading, unless a very serious breakdown has occurred.

Messrs. Apcar & Co. say:—The engines and machinery can be overhauled during the time occupied in discharging and loading cargo. It should not take more than a week opening out and shutting up all parts of the machinery.

The Committee of the Bengal Chamber of Commerce say:—Six or seven days, if there has been nothing to call for actual repairs.

(17) What is the greatest number (1) of sailing vessels of 1,000 tons, and (2) of steamers of 2,000 tons you have known to arrive in the port in one tide?

Messrs. Henderson & Co. say:—We cannot say, but the Port authorities will be able to give the information.

Messrs. Gladstone, Wylie & Co. say:—More than 12 ships and steamers have come into port in one tide, and many of them of greater tonnage than 1,000 and 2,000 tons for ships and the steamers respectively.

Messrs. Jardine, Skinner & Co. say:—We do not find that any daily register is kept, but our enquiries lead us to think that, if we except the Madras famine time, four ships and five steamers will be found to be about the greatest number that has arrived in the port in one tide.

Captain Yates, Harbour Master, says:—Fourteen vessels of sorts in one tide the same tide. Eight sailing vessels, the smallest being 1,162 tons, the largest 2,490, in one tide. Nine steam vessels, seven of which averaged 2,143 tons in one tide; over twenty vessels have moved in the port in one day frequently.

Lieutenant Stiffe, I.N., Port Officer, says:—Eleven according to my private journal.

Captain Thompson says:—Over ten together, ships and steamer.

Mr. Daly, Branch Pilot, says:—Some five or six of each.

Messrs. Duncan Brothers say:—May be ascertained from Port Commissioners' records.

Messrs. Apcar & Co. say:—We have frequently known four and five of each.

(18) In your opinion, would importers be equally willing to receive their goods at a conveniently situated railway station in Calcutta, as at the jetties, or from alongside ships at moorings?

Messrs. Hoare, Miller & Co. say:—Yes, but obviously only provided the arrangement of the new railway station afforded greater facilities for taking delivery than those now afforded at the jetties, and under existing conditions under which the piece-goods trade is carried on, we do not see how this could be.

Our object of all designs ought to be to diminish the cartage expenses. To meet this, the station from which the import cargo is to be taken by its consignees should be in the heart of the town, and sufficient space can, we imagine, hardly be found. Consignees would require 48 hours as a minimum time within which to remove their goods. In our opinion 48 hours would be found insufficient, and if enforced would entail more expense and disturbance than is felt at present.

Messrs. Mackinnon, Mackenzie & Co. say:—We should say no.

Messrs. Henderson & Co. say:—Yes, provided the ship's responsibility continues till so delivered.

Messrs. Gladstone, Wylie & Co. say:—Importers would not much mind whether they got their goods at a railway station or at the jetties, so long as there was no delay in delivering them, and they had no extra expense to pay.

Messrs. Ralli Brothers say:—Importers would prefer the Calcutta jetties. In the case of piece-goods the packages would be subjected to much rough handling in the transit by railway and from railway station to the Calcutta godowns. Besides ship's chafages in packages cannot be settled unless the goods are brought on the wharf or in the Calcutta godown and inspected by the captains of the vessels concerned.

Messrs. Prankissen Law & Co. say:—We would decidedly object to our baled and cased goods, and other kinds liable to be broken or injured by being much moved about, being landed at Diamond Harbour and subjected to additional handling, rolling and knocking about, and as far as we are aware of the feelings of the importers generally, they are also likely to be opposed to the change.

Messrs. Jardine, Skinner & Co. say:—Yes, provided arrangements can be made for settlement of claim for charge or other damage which the goods may show.

Lieutenant Stiffe, I. N., Port Officer, says:—I should say yes, but it is hardly likely the ship would deliver anywhere except over the side.

Mr. Grimley, Collector of Customs, says:—If the proposed junction station for the railways on either bank of the river is situated at a convenient distance from the mercantile part of the city, I see no reason why importers should not be willing to receive their goods there in preference to the risk and trouble necessarily involved in taking delivery over the gangway, or at the jetty sheds, and submitting to the fluctuating and sometimes extortionate charges for boat hire and demurrage.

Captain Thompson says:—More convenient, I think, to receive goods from the railway station.

Messrs. Duncan Brothers say:—Yes.

Messrs. Apcar & Co. say:—The largest importers should express their opinion on this question.

Mr. Inglis says:—Yes, provided the charges for delivery were no greater than at present.

Messrs. Gillanders, Arbuthnot & Co. say:—The success of the proposed scheme must, it appears, in a great measure depend upon the views of importers and exporters in the points here raised, and in the absence of further information we have some difficulty in answering the questions. It appears to us, however, that serious objections might be raised by both importers and exporters to taking and giving delivery of goods at a distance of about 40 miles from Calcutta, as all claims and disputes must necessarily be settled under the immediate notice of those interested. It is to be presumed that the Railway Company will undertake no responsibility in respect of goods carried, and in this case owners of vessels are likely to insist upon all claims and disputes with reference to imported cargo being finally decided on the wharf where the goods are landed direct from the ship, whilst on the other hand importers will only consent to such claims being settled in Calcutta where actual delivery will be taken. Similar difficulties might arise with reference to export cargo. Moreover, irrespective of the well-known objection to "breaking bulk" oftener than can be avoided, many descriptions of goods could not either be imported or exported from Diamond Harbour without additional charges for carriage being incurred unnecessarily, such as goods of great buik and weight intended for the Calcutta market, and bales of jute and jute fabrics which are almost always necessarily shipped in boats. Generally speaking, we think that the long distance between the proposed docks at Diamond Harbour and Calcutta, which we presume it is believed will continue to be the mercantile centre of Bengal, might lead to such inconvenience that importers and exporters might not be as wiliing to receive and ship their goods at railway station referred to as alongside ships.

The Committee of the Bengal Chamber of Commerce say:—As regards goods not liable to breakage or damage by handling, probably yes, if the situation of the station were really convenient not only to merchants' offices, but also in respect of loading at pleasure either into carts or boats; and if also the arrangements within the station itself, and its regulations, were convenient in respect of allowing ample room and necessary time for examination.

As regards fragile goods, certainly not.

(19) And would exporters be content to ship their goods at such a railway station, paying the same outward freight as if the goods were shipped over the jetties or overside ships at moorings?

Messrs. Hoare, Miller & Co. say:—The proposition involves so great a change in the system of shipping that we should have no confidence in a direct reply. Personal inspection of cargo on the part of the shippers at time of preparation of packing and of shipping is, or at all events has been, considered essential. The further the arrangements of the port go towards facilitating this personal supervision, and towards cheapening its cost, the better for the shippers, and the larger will be the trade of the port. It is exactly in this respect that we think the present arrangements of the port are very deficient. It costs one anna per maund to bring wheat or seeds from Howrah to Calcutta, *i.e.*, something from 2 per cent. to 4 per cent. in the value of the article for carrying it about one mile. Nevertheless a great deal of the wheat and seeds must be brought over here. Sometimes no doubt wheat, &c., &c., is carried by the railway, ready for and intended for direct despatch, but it is a fallacy to suppose all the wheat, &c., &c., that comes down goes off at once. Calcutta is, as a rule, the cheapest market for the shipper to buy in, for the simple reason that Calcutta serves as a centre for a hundred smaller contributing markets. Therefore it seems to us that the proposition, if carried out, involves a total change of system. The Calcutta operator must have establishments all over the country and at Diamond Harbour, and the opportunity for a saving in expense is difficult to foresee.

Messrs. Henderson & Co. say:—We think so, provided it could be arranged in Europe that delivery to a railway in Calcutta was considered shipment. There would be difficulty in this, but probably it is not insurmountable.

Messrs. Gladstone, Wylie & Co. say:—The same answer applies to exporters, but the ship or steamer would probably object to bear the extra expense, as there would probably also be claims to settle for any damage sustained by goods in transit which the vessel would be expected to pay. There would be innumerable disputes as to liability for damage, *i.e.*, whether the ship or railway had caused it.

Messrs. Ralli Brothers say:—At the same rate of freight, shippers would still prefer the Calcutta jetties or overside ships at moorings.

Messrs. Prankissen Law & Co. say:—We think, for the above reason, exporters may be deterred from shipping their goods by railway to Diamond Harbour, unless there was some decided advantage in doing so.

Messrs. Jardine, Skinner & Co. say:—Yes, if railway will grant clean receipts and the ships will grant clean bills-of-lading on these, the ships agreeing to accept the railway station measurement. Unless the ships work with the Railway Company in this way, exporters will not be content.

Lieutenant Stiffe, I.N., Port Officer, says:—Same applies.

Mr. Grimley, Collector of Customs, says:—The above remarks will apply equally to exporters shipping goods in boats or from the jetties.

As regards the question of a reduction in the rate of freight, I see no reason for any such concession if the vessel bears the expense of transit of the goods from the junction station into her hold, and *vice versâ*. This is, however, a matter which is sure to adjust itself in practice; it is therefore needless to dwell on it.

Captain Thompson says:—I should think so.

Messrs. Duncan Brothers say:—No, unless the Railway officials granted a receipt sufficiently binding, or equally so to a mate's receipt, on which a master would sign bills-of-lading.

Mr. Inglis says:—Ditto ditto (see answer 18).

Messrs. Apcar & Co. say:—Same as answer to No. 18.

While on this point, we would add that, if the railway expences of conveying goods from Diamond Harbour to Calcutta and from Calcutta to Diamond Harbour have to be borne by the ships, they would add such expenses to the rate of freight, unless it is clearly proved that they save such extra expenses by not proceeding up to Calcutta. In the case of a steamer carrying, say, 3,000 tons, this extra expense would amount to R6,000, *i.e.*, one rupee per ton on her inward cargo and the same on her outward cargo.

The Committee of the Bengal Chamber of Commerce say:—Yes, if they obtained clear "mate's receipts" at such railway station; but the condition is one difficult to compare, as the ship would certainly not accept any responsibility until the goods actually arrived alongside.

N.B.—These last two questions suppose that the railway expenses of conveying goods from Diamond Harbour to Calcutta and from Calcutta to Diamond Harbour would be borne by the ships.

The Committee of the Bengal Chamber of Commerce say:—This supposition would not be realised in the form stated, because the actual payment of railway freight by the ship would imply her acceptance of the risk of land carriage. It is of course conceivable that the merchant would obtain from the vessel a concession in sea freight equivalent to the railway charge, but that would only happen if the supply of tonnage at Diamond Harbour exceeded the demand for freight from Diamond Harbour; and this again could not happen otherwise than exceptionally, unless, as before stated, the vessel's gain by using the docks exceeded the dock charges by the amount of railway freight.

N.B.—On paragraphs 18 and 19.

(20) Would the rates of insurance on the hulls of vessels terminating their voyages at Diamond Harbour be lower than on the same vessels terminating their voyages at Calcutta?

Messrs. Hoare, Miller & Co. say:—We think not; one risk would probably be put against another.

Messrs. Mackinnon, Mackenzie & Co. say:—Inappreciably lower, we think.

Messrs. Henderson & Co. say:—We think not.

Messrs. Gladstone, Wylie & Co. say:—The Insurance Companies in England would have to decide this; but we think the difference, if any, would be very small.

Messrs. Ralli Brothers say:—No appreciable, if any, difference would be made.

Messrs. Jardine, Skinner & Co. say:—We do not think so, as statistics, we believe, will show that more vessels have been wrecked below than above Diamond Harbour in the last 20 years. We except the cyclones, which have occurred in that time, as wrecks caused by them are not due to navigation.

Lieutenant Stiffe, I.N., Port Officer, says:—This would be a question for the Insurance Companies. I cannot say how much, but I think not very much. In fact I am doubtful whether any extra insurance is now paid for the Hooghly beyond ordinary sea risks.

Mr. Milner, Branch Pilot, says:—I am not competent to answer this question, but presume the rates would be slightly lower. It is, I should say, an advantage to insurers that there is a dangerous river like the Hooghly, for the gains on risks are probably beyond all proportion to the losses.

Mr. Grimley, Collector of Customs, says:—Considering the reduction of risk by curtailment of distance and the avoidance thereby of several dangers, a reduction in the rate of insurance may fairly be expected. I do not, however, anticipate that the percentage of such reduction will be much of a factor either in favour of or against the termination of voyages at Diamond Harbour. This is, however, a matter which is sure to adjust itself by competition.

Captain Wilkinson, Superintendent, P. & O. Co., says :—Would not be considered by most insurance offices.

Messrs. Duncan Brothers say :—No.

Messrs. Apcar & Co. say :—No.

Mr. Inglis says :—The difference, if any, would be very trifling.

Messrs. Gillanders, Arbuthnot & Co. say :—We do not think that there would be any material difference in the rates of insurance, as those now current have been already reduced by competition to a minimum, though in the case of vessels terminating their voyage at Diamond Harbour the risk would be lessened.

The Committee of the Bengal Chamber of Commerce say :—Probably not.

(21) Would the rate of insurance on goods discharged at Diamond Harbour and goods shipped there be lower than insurance on the same goods brought to Calcutta direct or shipped from Calcutta direct? Supposing the rate of insurance to be less, what would be the proportionate reduction?

Messrs. Hoare, Miller & Co. say :—As above.

Messrs. Mackinnon, Mackenzie & Co. say :—Fancy not.

Messrs. Gladstone, Wylie & Co. say :—No, as the goods would doubtless be insured till arrival in Calcutta, no reduction would likely be made either way.

Messrs. Ralli Brothers say :—No difference in insurance is likely to be made.

Messrs. Jardine, Skinner & Co. say :—We do not think insurance would be lower.

Lieutenant Stiffe, I.N., Port Officer, says :—Same reply (see answer 20).

Captain Wilkinson, Superintendent, P. & O. Co., says :—See No. 20.

Mr. Daly, Branch Pilot, says :—I do not know.

Messrs. Duncan Brothers say :—No.

Messrs. Apcar & Co. say :—No, we think it is likely to be more, as the insurance offices have the extra risk of carriage by rail to Diamond Harbour, stowage, and shipment there.

Mr. Inglis says :—I doubt if the rate would be at all less.

The Committee of the Bengal Chamber of Commerce say :—Probably not.

(22) What would be, as nearly as you can give it, the average saving in time on each passage, up and down, to a steamer (1), and to a sailing vessel (2), which terminated her voyage at Diamond Harbour?

Messrs. Steel & Co. say :—Steamer one day, sometimes two; sailing vessel more frequently two than steamer.[1]

Messrs. Hoare, Miller & Co. say :—One day up and half a day down for a steamer.

Messrs. Henderson & Co. say :—A few hours, and of no practical value.

Messrs. Gladstone, Wylie & Co. say :—Coming up steamers would save three or four hours; going down about the same time: sailing ships the same as steamers coming up, but sometimes they might save a day in the downward towage. In other respects there would be little saving in time, as reaching Diamond Harbour about 2 o'clock and Calcutta at 6, they would probably not in either case get ready to discharge till the following morning.

Messrs. Jardine, Skinner & Co. say :—About half a day inward and one day outward. More in March, April, May, and June, when there is not so much water over the James and Mary shoal.

Captain Yates, Harbour Master, says :—

$$\left.\begin{array}{l}\text{(1) Four hours}\\ \text{(2) Five hours}\end{array}\right\}\text{up.} \qquad \left.\begin{array}{l}\text{(1) Frequently one day}\\ \text{(2) Ditto ditto}\end{array}\right\}\text{down.}$$

Lieutenant Stiffe, I.N., Port Officer, says :—Four hours up, one day down, for large vessels: if not, then 6 hours.

A vessel leaves Saugor on the flood and reaches town nearly invariably in one tide or eight to ten hours. I assume towage in the case of a sailing vessel.

Going down a vessel would probably get out from Diamond Harbour in one day instead of two, as at present.

The great value would be this, that a vessel going down would not, as now, have to anchor at a place like Fisherman's Point, which, in the freshets, is highly undesirable.

Mr. Elson, Master Pilot, says :—Ships and steamers would always save half a day, and often a whole day, by terminating the voyage at Diamond Harbour.

Mr. Milner, Branch Pilot, says :—This question cannot be satisfactorily answered without first knowing at what time of tide a vessel will be able to leave the docks. I have stated elsewhere that, if a deep steamer does not leave the docks till high water, that a similar steamer leaving Calcutta the same day would overhaul her.

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[1] Verbally by Mr. Steel to Colonel Trevor.

Mr. Grimley, Collector of Customs, says:—The saving of time to a vessel terminating her voyage at Diamond Harbour would, in the case of a steamer, ordinarily be about 3½ hours, and in the case of a sailing vessel about 5 hours. But it may happen that a vessel of deep draft becomes neaped, and has in consequence to remain at anchor for some four or five days.

Captain Wilkinson, Superintendent, P. & O. Co., says:—See No. 1.

Captain Thompson says:—Sailing vessels one day, steamers half a day.

Mr. Daly, Branch Pilot says:—Ships would invariably save one or two days and steamers one at least.

Messrs. Duncan Brothers say:—(1) Steamer one day up and down; (2) sailing two days up and down.

Messrs. Apcar & Co. say:—

(1) A steamer sometimes 4 or 5 hours, at other times a day, according to tides.
(2) A sailing vessel one day.

Mr. Inglis says:—In the case of a steamer and a sailing ship being towed by steam the saving would be much the same, four to five hours, in the upward run, and half a day to a whole day down.

Messrs. Gillanders, Arbuthnot & Co. say:—Probably from half to one day both up and down.

The Committee of the Bengal Chamber of Commerce say:—Roughly, the saving to a steamer might average half a day to one day, and to a sailing vessel one and a half to two days.

(23) What would be the value of this saving of time to a steamer carrying 3,700 tons of cargo, and to a sailing ship carrying 2,400 tons of cargo?

Messrs. Steel & Co. say:—£50 per day steamer. [1]

Messrs. Hoare, Miller & Co. say:—A saving of a day is worth about £60 or 70 to a steamer of 3,700 tons burden.

Messrs. Gladstone, Wylie & Co. say:—None at all, as, if need be, the steamer can commence her discharge immediately she gets alongside a jetty four hours after passing Diamond Harbour, while she would only be able to get into dock at certain times of tides, and might be discharging in Calcutta before she would be docked at Diamond Harbour.

Mr. Grimley, Collector of Customs, says:—The value of the saving in time to a steam vessel terminating her voyage at Diamond Harbour would be represented by the cost of coal consumed in steaming the extra distance, the salary of the commander, the wages of the crew, the disbursements for stores, the loss of interest on the capital laid out on the vessel, and the possibility of a profitable charter falling through by delay in arrival in consequence of the dangerous navigation.

Captain Wilkinson, Superintendent, P. & O. Co., says:—In a passenger steamer the day's victualling would be saved.

Captain Thompson says:—Steam-hire alone to a sailing vessel, R600.

Mr. Daly, Branch Pilot, says:—To the steamer a day's expenses in wages and coal, and to the sailing ship wages and five to six hundred rupees per diem for steam-hire.

Messrs. Duncan Brothers say:—£30 per day for steamer. £30 per two days for sailing ship. These represent the owner's cost.

Messrs. Apcar & Co. say:—Not much.

Messrs. Gillanders, Arbuthnot & Co. say:—A sailing vessel's ordinary expenses are usually calculated at four pence and a steamer's at eight pence both per ton registered per day.

The Committee of the Bengal Chamber of Commerce say:—The value of this time to such a steamer may be set down at R500, and to such a sailing vessel R350.

(24) What would be the saving of coal to a steamer of the same size?

Messrs. Steel & Co. say:—£20.*

Messrs. Hoare, Miller & Co. say:—From 30 to 40 tons.

Messrs. Gladstone, Wylie & Co. say:—Not more than 10 tons on the double journey, up and down.

Messrs. Jardine, Skinner & Co say:—About 15 to 20 tons.

Lieutenant Stiffe, I.N., Port Officer, says:—Not more than 8 or 10 tons up and 20 tons down at the outside.

Mr. Grimley, Collector of Customs, says:—The saving of coal will depend on the horse-power of the engines and the construction of the boilers. The *Pekin*, a P. and O. vessel, 3,900 tons and 600 horse-power, burns about 35 tons per diem at 11 knots an hour, and from 45 to 50 tons at 13 knots. The *Indus*, 3,462 tons and 600 horse-power, burns 10 or 12 tons less. Very few of the canal steamers burn more than 20 tons at 9 knot speed.

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[1] Verbally by Mr. Steel to Colonel Trevor.

Captain Wilkinson, Superintendent, P. & O. Co., says:—About 50 tons to a 4,000-ton steamer.

Mr. Daly, Branch Pilot, says:—The quantity she would consume per diem.

Messrs. Duncan Brothers say:—20 tons up and down.

Messrs. Apcar & Co. say:—Value of 5 hours' coal, say R75 to R100.

Messrs. Gillanders, Arbuthnot & Co. say:—Probably ten tons on an average both up and down; 20 tons in all.

The Committee of the Bengal Chamber of Commerce say:—Probably 15 to 20 tons.

(25) What would be the saving of towage to a ship of the same size?

Messrs. Steel & Co. say:—£80.[1]

Messrs. Henderson & Co. say:—Probably R200.

Messrs. Gladstone, Wylie & Co. say:—Probably no saving in the upward towage except in case of light draft ships arriving in the south-west monsoon and sailing up. But they can also sail up to Calcutta. A day's steam, or R600, might sometimes be saved on the downward towage.

Messrs. Jardine, Skinner & Co. say:—R600 per day.

Captain Yates, Harbour Master, says:—Outward probably a day's hire; inward would depend on rules that might obtain under the altered conditions.

Lieutenant Stiffe, I.N., Port Officer, says:—One day's hire going out. Coming up, I believe, very little, as the tugs want a lump sum from sea to Calcutta, which cover their expense going down, seeking and detention.

Mr. Elson, Master Pilot, says:—The same reply as to 22 above.

Mr. Grimley, Collector of Customs, says:—The saving in towage charge to a ship of the given burthen would ordinarily represent two days' steam, which for a first-class tug would not be below R600 per day.

Captain Thompson says:—R600.

Mr. Daly, Branch Pilot, says:—Five to six hundred rupees per diem.

Messrs. Duncan Brothers say:—A day's towage, R600 per day, upward; same downward.

Messrs. Apcar & Co. say:—Proceeding up, say R500 to R600. Proceeding down, say R500 to R600.

Messrs. Gillanders, Arbuthnot & Co. say:—We should estimate the saving both up and down the river at R1,000 on an average.

The Committee of the Bengal Chamber of Commerce say:—Very considerable, as the ship would often sail up to Diamond Harbour; say on an average R1,500.

(26) What would be the saving of pilotage to a steamer paying on 22 feet inwards and 24 feet outwards?

Messrs. Steel & Co. say:—£35.[1]

Messrs. Henderson & Co. say:—Nothing we think, unless the pay of pilots be reduced, which we think undesirable.

Messrs. Gladstone, Wylie & Co. say:—

	R	a.	p.	
Saving	117	12	0	inwards.
„	153	12	0	outwards.

Messrs. Jardine, Skinner & Co. say:—

	R	a.	p.
Inwards	117	8	6
Outwards	153	6	5

Captain Yates, Harbour Master, says:—Three-twelfths each way—

	R	a.	p.
Inwards	111	12	0
Outwards	153	12	0

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[1] Verbally by Mr. Steel to Colonel Trevor.

Lieutenant Stiffe, I.N., Port Officer, says :—

See Pilotage table.
Total 680 inwards
less ¼—170

3)510 whole way for steamer 22 feet.

170-0 saving
819
Deduct ¼—205

3)614

204-11 saving outwards.

Mr. Elson, Master Pilot, says :—₨157 and ₨205, total ₨362.

Mr. Milner, Branch Pilot, says :—

	₨	*R a. p.*
Inwards to Calcutta	470	
Ditto Diamond Harbour	362	
Gain		118 0 0
Outwards from Calcutta	608	
Ditto Diamond Harbour	460	
Gain		148 0 0
TOTAL		266 0 0

Mr. Grimley, Collector of Customs, says :—The saving in pilotage charge would be four-twelfths of the ordinary charge for handling a vessel of such draft.

Mr. Daly, Branch Pilot, says :—At the present rate one-quarter each way.

Messrs. Duncan Brothers say :—₨435.

Messrs. Gillanders, Arbuthnot & Co. say :—Under the Port Commissioners' scale now in force, the saving of pilotage to a steamer would be ₨156-12 inwards and ₨204-12 outwards.

The Committee of the Bengal Chamber of Commerce say :—

	₨
Inwards, the Committee believe	156
Outwards	255
Total saved	411

(27) What would be the saving of pilotage to sailing ships paying on 22 feet outwards and inwards?

Messrs. Steel & Co. say :—£30.[1]

Messrs. Henderson & Co. say :—As above (see answer 26).

Messrs. Gladstone, Wylie & Co. say :—

	R	*a.*	
Saving	117	12	inwards.
„	129	12	outwards.

Messrs. Jardine, Skinner & Co. say :—

	R	*a.*	*p.*	
Inwards	156	11	6	less ¼£ for steamers.
Outwards	172	10	6	„ „

Captain Yates, Harbour Master, says :—Three-twelfths each way—

	R	*a.*	*p.*
Inwards	117	12	0
Outwards, vessel in tow	129	12	0

Lieutenant Stiffe, I.N., Port Officer, says :—

3)680

226-11 saving inward.

3)691

230 „ outward.

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[1] Verbally by Mr. Steel to Colonel Trevor.

Mr. Elson, Master Pilot, says:—Sailing ships of this draught must take steam, so their pilotage is the same as in steamers—R157 and R173, total R330.

Mr. Milner, Branch Pilot, says:—

		R	a.	p.
Pilotage from sea to Calcutta, steam from Saugor		521	0	0
Ditto sea to Diamond Harbour, steam from Saugor		405	0	0
	Gain	116	0	0
Pilotage from Calcutta to sea, steam the whole way		518	0	0
Ditto Diamond Harbour, steam to sea		346	0	0
	Gain	172	0	0

Pilotage outwards from Diamond Harbour is only charged on $\frac{8}{12}$ths, as the vessel would not probably go above Diamond Harbour telegraph station outward-bound.

Mr. Daly, Branch Pilot, says:—If towed by a tug the same as a steamer.

Messrs. Duncan Brothers say:—R330.

Messrs. Gillanders, Arbuthnot & Co. say:—And in the case of sailing vessels towed by steam tugs, R156-12 and R172-8 respectively.

The Committee of the Bengal Chamber of Commerce say:—Assuming the vessel takes steam in all cases, the saving—

	R
Inwards would be	156
Outwards	216
Total saved	372

(28) What would be the saving of mooring hire to a steamer and to a sailing ship of the given size?

Messrs. Steel & Co. say:—£15 to £20; £20 to £25.[1]

Messrs. Henderson & Co. say:—Little or nothing we think.

Messrs. Gladstone, Wylie & Co. say:—The mooring hire here is R5 per day for a ship of 1,000 tons, and R9 per day for a steamer of 2,000 tons, but we cannot say what saving there would be by lying at Diamond Harbour, as we do not know what charges are proposed to be levied there. We presume with such an expenditure moorings will not be free.

Messrs. Jardine, Skinner & Co. say:—

Steamer of 3,000 tons, R15 per day.
Sailing ship of 1,600 tons, R7 per day.

Captain Yates, Harbour Master, says:—Daily mooring hire—

	R
Tons 2,000	9
„ 1,000	5

Lieutenant Stiffe, I.N., Port Officer, says:—The rates are per diem, and can be best given by the Port Commissioners.

Mr. Grimley, Collector of Customs, says:—According to port rules a steamer of over 3,000 tons would be required to pay R15, and a sailing ship of 2,500 tons R11 per day for hire of moorings.

Mr. Daly, Branch Pilot, says:—This would entirely depend on what the charges for the proposed docks would be for berthing a ship.

Messrs. Duncan Brothers say:—R9, being one day's mooring hire for steam ship; R16, being two days' mooring hire for ship.

Messrs. Gillanders, Arbuthnot & Co. say:—For a steamer of about 3,600 tons gross remaining in port on an average 14 days, mooring hire at R15 per day would amount to R210, and in the case of a sailing vessel of about 1,650 tons remaining, say 45 days, at R7 per day, the mooring hire would be R315.

The Committee of the Bengal Chamber of Commerce say:—Mooring hire is a daily charge, and the economy would depend upon the number of days which would be saved by using the dock. As a rough estimate, if a steamer gained two days by the dock, she would save R30, and if a sailing ship gained a month (which question 30 implies) she would save R210.

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[1] Verbally by Mr. Steel to Colonel Trevor.

(29) How much could a steamer of the given size afford to pay for the expense of docking and remaining in dock nine days in exchange for the saving of time, coal, pilotage, mooring hire, and insurance?

Messrs. Steel & Co. say:—£150.*

Messrs. Gladstone, Wylie & Co. say:—Very little. The saving would, in our opinion, be by coming on to Calcutta.

Lieutenant Stiffe, I.N., Port Officer, says:—This depends how long she stays at moorings. She would be longer than nine days at moorings probably. The items coal and pilotage are given already.

Mr. Grimley, Collector of Customs, says:—It would not be possible in every instance for a steam vessel to discharge and load cargo within nine days, unless her freight was pre-engaged, and her export cargo at hand, so that loading and unloading could go on simultaneously; otherwise her loading time would be reduced to only four or five days; and it would be difficult to effect a charter for a vessel with so few running days to load in, as the demurrage would be heavy if she remained in dock beyond the prescribed period, and to get out of dock and load in the stream would be equally, if not more, expensive.

Messrs. Duncan Brothers say:—R50 per diem.

Messrs. Apcar & Co. say:—We would prefer to have the steamer at Calcutta; the saving of time by easy and immediate communication, and numerous other slight advantages, we think, would more than compensate for any saving in cost by stopping at Diamond Harbour.

Messrs. Gillanders, Arbuthnot & Co. say:—Coal, pilotage, mooring hire, and insurance (if any) would amount to about R800. We should roughly estimate the saving time at R500 per day, or for five days R2,500, making R3,300 in all.

The Committee of the Bengal Chamber of Commerce say:—If she were loaded within nine days she would gain about R2,300, as compared against going to Calcutta and loading in eleven days. How much she would choose to pay for this benefit is another question. Much would obviously depend on the ruling of freights.

(30) How much could a sailing ship of the given size afford to pay for the expense of docking and remaining in dock fourteen days in exchange for the advantages gained by the saving in time, pilotage, towage, mooring hire, and insurance?

Messrs. Steel & Co. says:—£165.[1]

Messrs. Gladstone, Wylie & Co. say:—We are doubtful if there would be much saving, if any, to a sailing ship, except perhaps at times when they might save a day's steam hire.

Lieutenant Stiffe, I.N., Port Officer, says:—The same remarks apply.

Mr. Grimley, Collector of Customs, says:—As regards a sailing vessel the case would be somewhat different; her expenses to and from Calcutta for steam alone would be heavy, and although her freight would be engaged at a lower rate than a steamer, her disbursements altogether would not be near so heavy when lying at Diamond Harbour as those of a steam vessel, and she would also have a longer time to discharge and load.

Messrs. Duncan Brothers say:—R30 per diem.

Messrs. Gillanders, Arbuthnot & Co. say:—Pilotage, towage, mooring hire and insurance (if any) would be about R1,550, and adding 31 days for saving of time at R250 per day, or R7,750, the total amount would be R9,300. This estimate, however, is based on the assumption, indicated by you, that a sailing vessel could be discharged and loaded in 14 days; but this, in our opinion, could very seldom be accomplished.

The Committee of the Bengal Chamber of Commerce say:—This question is a difficult one to answer usefully. Taken with those preceding, it implies that the vessel would save 31 to 32 days by using the dock, and it could no doubt from this basis be shown that her owners would be gainers by some R7,000 up to even R9,000, according to the general ruling of freights. It must not, however, be forgotten that owners of sailing ships have been known to keep them here, deteriorating in our climate, for upwards of 12 months at a certain loss of at least R35,000, and that merely from unwillingness to face a decline in freights equivalent to, say, R15,000.

(31) Supposing that a steamer were charged a sum of £120 for docking and dock hire in your opinion, would the owners of such a steamer prefer to dock at Diamond Harbour rather than proceed to Calcutta?

Messrs. Hoare, Miller & Co. say:—It would seem to be cheaper to a steamer to pay £120 for accommodation at Diamond Harbour than to expend time and coal in coming up to Calcutta, where the port dues are heavy; but everything would depend on the loading facilities at Diamond Harbour.

Messrs. Henderson & Co. say:—Very doubtful.

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[1] Verbally by Mr. Steel to Colonel Trevor.

Messrs. Gladstone, Wylie & Co. say:—We believe that the owners would prefer coming on to Calcutta rather than have to discharge at Diamond Harbour and be charged with the risk and expense of forwarding cargo to its destination by rail as well as bringing the cargo down to Diamond Harbour, and perhaps sometimes have it shut out when it would be at the risk of the ship.

Lieutenant Stiffe, I.N., Port Officer, says:—Yes, if the same facilities were available for loading and discharging cargo, and the cargo was obtainable.

It would also depend upon whether jetty charges on all the goods landed were to be paid, and how heavy they were.

Mr. Milner, Branch Pilot, says:—I think that the owner would send his ship to Calcutta because, besides this charge, he would have to pay R1 per ton for every ton of cargo he put out and took in for railway conveyance to and from Calcutta.

Mr. Grimley, Collector of Customs, says:—As a vessel, I understand, would have to pay all railway charges for transit of her inward and outward cargoes to and from Calcutta, the benefit to be derived by a steamer from docking at Diamond Harbour in preference to coming up to Calcutta will, apart from avoiding the risk of navigation, depend entirely upon the proportion between the railway charges and the cost of bringing up the vessel by the river.

Captain Wilkinson, Superintendent, P. & O. Co., says:—If the owners took the risk of insurance themselves, I have no doubt they would prefer stopping at Diamond Harbour.

Mr. Daly, Branch Pilot, says:—I do not know the Calcutta charge.

Messrs. Duncan Brothers say:—No.

Mr. Inglis says:—Now that port dues are reduced, it would be much cheaper for the steamer to come up to Calcutta.

Messrs. Gillanders, Arbuthnot & Co. say:—So far as owners alone are concerned, they would probably prefer Diamond Harbour, provided they were satisfied that their interests would receive the same care and protection as in Calcutta.

The Committee of the Bengal Chamber of Commerce say:—Given equal facility for engaging cargo at equal rates, and given that they are not to be called upon to accept more than customary risks and costs in connection with cargo, it is reasonable to suppose that the owners of the steamer would prefer docking at Diamond Harbour.

(32) And supposing the charge for the same services to a sailing ship to be £70, would the owners prefer to dock at Diamond Harbour rather than proceed to Calcutta?

Messrs. Henderson & Co. say:—Very doubtful.

Messrs. Gladstone, Wylie & Co. say:—The same answer applies.

Lieutenant Stiffe, I.N., Port Officer, says:—Yes; same qualification.

Mr. Milner, Branch Pilot, says:—He would prefer sending his ship to Calcutta until it was shown he would gain by her docking at Diamond Harbour.

Mr. Grimley, Collector of Customs, says:—As regards a sailing vessel, the charge for docking and dock-hire would be compensated for by the saving of four days' inwards and outwards steam-hire, *plus* possible reduction in rate of insurance, mooring-hire, and pilotage charges.

Mr. Daly, Branch Pilot, says:—They would dock at Diamond Harbour, as they would then escape having to pay a steam-tug for shooting the Hooghly Bridge, which is a heavy item in itself.

Messrs. Duncan Brothers say:—No.

Mr. Inglis says:—The same answer to this question.

The Committee of the Bengal Chamber of Commerce say:—Always supposing that the conditions previously assumed were fulfilled, the owner most undoubtedly should prefer to use the dock.

The Committee of the Bengal Chamber of Commerce say:—*Note.*—It is to be observed that these questions are answered exclusively from the ship-owner's point of view, and that for the nonce it is assumed that the consignee of the inward cargo will submit to the vessel going to the dock.

(33) Would a dock at Diamond Harbour be used by steamers and sailing ships for the purpose of calling there for coal or part cargo on their way down the river from Calcutta, with the object of going so far down the river at a lighter draft of water?

Messrs. Hoare, Miller & Co. say:—It is very likely Diamond Harbour might prove a useful coaling station. Calcutta cargoes outward are either whole cargoes of one article, for instance, of wheat, of seed, of jute, or else assorted. Dead weight at the bottom and light or measurement cargo above. So far as we can at present see, the only cargo that is likely to find its way to Diamond Harbour from Calcutta is wheat and seeds, and therefore the only vessels that could make use of Diamond Harbour for a loading port would be such vessels as may engage themselves to carry whole cargoes, or cargoes assorted, of these articles.

Messrs. Henderson & Co. say:—Not if the East Indian Railway could deliver coal at the Calcutta jetties.

Messrs. Gladstone, Wylie & Co. say:—If they came to Calcutta, they would prefer filling up there rather than delaying at Diamond Harbour for the balance of their coal or cargo, unless indeed the river became more shallow than it is now above Diamond Harbour, when such a step might be necessary.

Messrs. Jardine, Skinner & Co. say:—No.

Captain Yates, Harbour Master, says:—I have known instances in the dry season of P. & O. steamers outward bound going to Diamond Harbour two or three days before their date for sailing, on account of the James and Mary's shoal, on falling tides. They might in such cases use the docks. This has not occurred for some years.

Lieutenant Stiffe, I.N., Port Officer, says:—Very likely if there were inconveniences to load in the stream, but I do not think they would dock to complete cargo, and so incur heavy charges.

Mr. Milner, Branch Pilot, says:—Very deep loading steamers would take advantage of this facility on the neap tides in the months of March, April, May, and June, when there was little water in the eastern gut of the James and Mary's.

Mr. Grimley, Collector of Customs, says:—It is probable that all deep vessels would consider it desirable to leave Calcutta at a light draft and coal or take in the balance of their cargoes at Diamond Harbour, especially if they feared being neaped; but the expenses at both ends, *plus* railway charges on goods, would be likely to be heavy.

Captain Wilkinson, Superintendent, P. & O. Co., says:—Vessels that are not under contract to leave port on a certain day would make their arrangements to leave on the springs, so that there would be no necessity to stop at Diamond Harbour.

Captain Thompson says:—Large vessels would probably do so.

Mr. Daly, Branch Pilot, says:—I should say it would, could the article be procured there as cheaply as it could at Calcutta.

Messrs. Duncan Brothers say:—We scarcely think so.

Messrs. Apcar & Co. say:—We do not think vessels would do so.

Mr. Inglis says:—Very rarely I should think, and only in very exceptional states of the tide.

Messrs. Gillanders, Arbuthnot & Co. say:—Possibly in some cases of vessels of extremely heavy draft, but very rarely.

The Committee of the Bengal Chamber of Commerce say:—It is most unlikely that a vessel would enter the dock for such purpose but very exceptionally; she might anchor in the stream off the docks to complete loading. Passengers might probably use the railway to some extent.

(34) During the year 1881, what proportion of piece-goods or other imports were despatched up-country direct from the vessels without being taken to the Calcutta godowns?

Messrs. Hoare, Miller & Co. say:—So far as our knowledge goes, the proportion of piece-goods sent up-country without being taken to Calcutta godowns is infinitesimal. A very large proportion, probably three-fifths, is sent without being opened, but hardly any piece-goods are taken direct from steamer to railway station. Of other cargo we believe iron and machinery are often sent from ship's side to railway station.

Messrs. Henderson & Co. say:—We doubt if any piece-goods have been so treated. Salt is thus despatched to some extent. Refer to Custom House records. Other imports so treated very small, if at all.

Messrs. Ralli Brothers say:—Almost nothing.

Messrs. Prankissen Law & Co. say:—As far as our experience is concerned, very little, if any, of our staple imports is despatched up-country direct from vessels.

Messrs. Jardine, Skinner & Co. say:—We do not think any.

Mr. Grimley, Collector of Customs, says:—It is not possible for piece or other goods to be despatched direct up-country from overside vessels, as they have to undergo Customs examination, whether dutiable or free; but even if such were not the case, I do not think there would be any extensive direct despatches, especially in the large quantities in which several of such goods are imported.

Messrs. Gillanders, Arbuthnot & Co. say:—Piece-goods are seldom or never despatched up-country direct from vessels. Salt and metals often are, but it would be difficult to give the figures.

The Committee of the Bengal Chamber of Commerce say :—Little, if anything.

(35) In 1881 what quantity of produce was exported direct without being warehoused in Calcutta?

Messrs. Hoare, Miller & Co. say :—We cannot give figures. In order to export produce direct from railway or from boat, it is of course necessary that the vessel for which the produce is intended should be ready to receive it on the day or the day after the produce arrives: or to put it the other way, it is necessary for the produce to arrive in accordance with the convenience of the vessel. It is difficult to ensure this happening. Produce often arrives from up-country in a condition ready for shipment, but owing to circumstances, accidental or otherwise, it cannot be shipped immediately on receipt, and as there is no accommodation for it at Howrah, it has to be stored in Calcutta at considerable additional expense.

Messrs. Henderson & Co. say :—Quantity unknown, but we believe very trifling.

Messrs. Ralli Brothers say :—Of jute, almost nothing. Of seeds and wheat, about 40 per cent. of the total were exported direct. It is to be noted, however, that whatever quantity is exported direct from the Howrah railway station is subject to examination by the shippers in the presence of the sellers in order to ascertain condition, quality, weights, and refraction of the different parcels before shipment. Such operation could not be effected satisfactorily at Diamond Harbour unless at the great expense of keeping for that purpose there a separate establishment by each shipper and seller.

Mr. Grimley, Collector of Customs, says :—Produce water-borne from the producing districts is ordinarily warehoused in Calcutta or transferred into licensed cargo-boats before shipment, as the vessels in which it is brought down are not licensed to ply within the port, but goods brought down by rail are generally shipped direct from the railway stations.

Messrs. Duncan Brothers say :—All jute must be regarded as stored in Calcutta to be pressed. Quantity of other exports stored we estimate at 237,000 tons (being half), obtained as under :—

	Tons.
Saltpetre	10,151
Sugar	3,167
Rice	52,517
Wheat	208,928
Linseed	122,658
Rapeseed	44,073
Poppy-seed	9,101
Teel-seed	23,469
TOTAL	474,064

Messrs. Gillanders, Arbuthnot & Co. say :—We have no figures beside us, but should say a considerable portion of the arrivals by rail of wheat, seeds, and cotton were exported direct in 1881.

The Committee of the Bengal Chamber of Commerce say :—Of wheat and seeds a very large proportion, which has a distinct tendency to increase. Much cotton. No jute. Very little rice.

(36) Is it likely that the docks would be used by vessels salt laden, and how far could the salt trade be carried on from Diamond Harbour?

Messrs. Hoare, Miller & Co. say :—A dock at Diamond Harbour connected with Calcutta by rail could, we should suppose, be most conveniently availed of by vessels with salt cargoes. Assuming the docks and railway to be constructed, it seems to us the use to which they would be most likely to adapt themselves would be to receive inward cargoes of salt and occasionally coal, and to load outward full cargoes of wheat and seed. We do not see how the docks and railways could be availed of by Liner steamers for assorted cargoes.

Messrs. Mackinnon, Mackenzie & Co. say :—Only to a small extent we should say.

Messrs. Henderson & Co. say :—No, unless bonded salt golahs existed at Diamond Harbour. With such golahs the risk of craft to Calcutta would be an additional risk, while to carry by rail would probably entail loss of weight and cost of packing on bags.

Messrs. Gladstone, Wylie & Co. say :—Golahs would have to be built to store the salt, but the salt trade could not be carried on at Diamond Harbour.

Messrs. Prankissen Law & Co. say :—As things at present stand, no salt-laden vessels could use the docks, and the salt trade could not be carried on from Diamond Harbour.

Messrs. Jardine, Skinner & Co. say:—We do not think so. There would not be the same facilities for selling overside into boats as at Calcutta. The boats which take salt from ships in Calcutta for the interior are not strong enough for Diamond Harbour, and if they did not go there, salt at Diamond Harbour would sell at a disadvantage.

Lieutenant Stiffe, I.N., Port Officer, says:—Probably it would depend on the facilities given or available for distributing salt in the neighbourhood.

Mr. Grimley, Collector of Customs, says:—I am doubtful whether the proposed docks would be used by salt-laden vessels, as the class of purchasers of this article would object to receive delivery from second or third hands, and it would cause constant friction between the purchaser, the master or agent of the vessel, the Customs Officer, the Dock authorities, the Railway officials, and the Government, as regards correct outturn. It would further destroy proper check on the revenue, open innumerable doors to fraud, and altogether revolutionize the existing system which is found to work satisfactorily. Further, it would considerably interfere with bonding operations, and despatch to marts to which it must necessarily be water-borne.

Messrs. Duncan Brothers say:—No; under existing conditions salt is retailed from ship's side, and the vessel, we assume, would not be allowed to remain in dock long enough to sell her cargo by retail.

Mr. Inglis says:—Unless salt golahs were built and salt ships could depend on getting filled up with an outward cargo at Diamond Harbour within a reasonably short time, they would prefer coming up to Calcutta, I should say.

Messrs. Gillanders, Arbuthnot & Co. say:—Docks at Diamond Harbour, if well supplied with bonded warehouses, would facilitate the rapid discharge of ships bringing cargoes of salt, and might, we think, be availed of to a considerable extent, provided customs regulations were so framed as to encourage both salt merchants and owners of vessels bringing salt to make use of the docks.

The Committee of the Bengal Chamber of Commerce say:—Most unlikely, unless a boat canal were constructed from, say, Tolly's Nullah, and so brought to the docks that the boats could be laden from bonded warehouses into which import vessels should discharge. Even then the question implies a complete dislocation of the trade and migration of those concerned in it. Moreover, as those boats which took salt away are the same that have brought produce down, the question implies a re-arrangement of other trades as well as that in salt.

(37) Is it likely that the docks would be used by vessels laden with coal; and if country coal could be delivered by rail at Diamond Harbour at sufficiently low rates, is it probable that any export trade would result?

Messrs. Henderson & Co. say:—This depends on the railway charge. The risk of bringing coal in boats by river to Calcutta would be considerable. We think not, so far as can be judged at present.

Messrs. Gladstone, Wylie & Co. say:—Salt and coal-laden vessels, like all others, would only care to make use of docks at Diamond Harbour if they could do so at less expense than by coming to Calcutta.

Messrs. Jardine, Skinner & Co. say:—If Diamond Harbour were to become a popular port, and many steamers load from it, some coal ships would no doubt discharge there to meet steamer requirements. We do not think an export trade in coal would be likely to result.

Lieutenant Stiffe, I.N., Port Officer, says:—I don't think there is any export trade of country coal. If there be, I should say the docks would not compete with Calcutta. It comes by East Indian Railway and is shipped into lighters. Possibly, if the East Indian Railway is brought to Diamond Harbour.

Mr. Grimley, Collector of Customs, says:—It is doubtful if coal would bear the extra charge for transit to Diamond Harbour; no export trade would therefore be likely to result.

Captain Wilkinson, Superintendent, P. & O. Co., says:—If steamers went in to the dock as a permanent measure, colliers would have to take their cargoes there.

Mr. Daly, Branch Pilot, says:—I should say there ought to be a considerable export trade to Madras, for instance, where there is no country coal and many railways.

Messrs. Duncan Brothers say:—The docks would probably be used for discharging coal, as cargoes of this article generally come to one buyer or importer. Yes, to a moderate extent.

Messrs. Apcar & Co. say:—No.

Mr. Inglis says:—I think not.

Messrs. Bird & Co. say:—When the Hooghly Bridge is built, and if wagons can be discharged direct into the ship, we think it probable, under the conditions named in clause 37, that a small export trade would result. We do not think it probable ships importing coal would use the Diamond Harbour docks.

Messrs. Gillanders, Arbuthnot & Co. say:—Steamers coming to the new docks would often require coal, and there would be some inducement to coal ships to discharge there, but not much, as the discharge in Calcutta is fairly rapid. The dock would not, we think, be likely to make much difference in the export of coal.

The Committee of the Bengal Chamber of Commerce say:—Certainly, if the large Steam Companies take to the dock; otherwise—no. As regards an export trade in coal, the Committee think that some trade, though probably not a very large one, might be hoped for if such coal could be delivered at Diamond Harbour at sufficiently low rates.

(38) Is it likely that coasting vessels would use the docks?

Messrs. Mackinnon, Mackenzie & Co. say:—No.

Messrs. Henderson & Co. say:—We think not.

Water carriage on a run like the Hooghly must, we think, be cheaper than any kind of land carriage; therefore the country will receive its imports on more favourable terms if import vessels come up the river as far as possible.

Captain Yates, Harbour Master, says:—I should think not.

Messrs. Gladstone, Wylie & Co. say:—We think not.

Lieutenant Stiffe, I.N., Port Officer, says:—No, the coasting trade by native craft is almost extinct.

Mr. Grimley, Collector of Customs, says:—Judging from the nature of the cargoes carried by coasting vessels, I do not anticipate the use by them of the proposed docks.

Captain Thompson says:—No.

Mr. Daly, Branch Pilot, says:—No, if they could save money by not doing so.

Messrs. Duncan Brothers say:—They might, but not to any great extent.

Mr. Inglis says:—I think not.

Messrs. Gillanders, Arbuthnot & Co. say:—As the bulk of the coasting trade is carried on by steamers, the agents of the companies interested will be able to give reliable information on the subject.

The Committee of the Bengal Chamber of Commerce say:—No; and it must be remembered that the total number of steamers which visited Calcutta in 1881 were one-half coasters.

Memorandum from the Committee of the Bengal Chamber of Commerce:—Having thus replied to the queries submitted to them, the Committee beg leave to add a record of their opinion that the success of docks at Diamond Harbour takes for granted so many doubtful conditions, and, if assured, would involve so violent a revolution of the course of trade as at present constituted, that docks in that locality should be undertaken only after the most exhaustive examination of every feasible scheme for giving sufficient development to our resources within the range of the existing port, and for simultaneously reducing the charges on shipping and the risks to which vessels are now exposed. Particularly the Committee trust that full consideration may be given to the proposal to excavate docks here, with a ship canal to the Mutlah.

From LIEUTENANT A. W. STIFFE, late I.N., Port Officer, Calcutta, to the Secretary to the Government of Bengal, Public Works Department—No. 2534, dated Calcutta, the 5th May 1881.

In reply to your letter No. 60M. of 25th February 1881, I have the honour to report that it does not appear from the records that the Hooghly is deteriorating as a navigable river. Last year a ship was taken safely down the river drawing 26 feet, which exceeds anything previously attempted. Further, no ships have been lost in the river since the *Queen Anne* in September 1878. I attach a diagram showing the monthly state of the principal bars above Diamond Harbour, which, while it shows considerable fluctuations, does not, in my opinion, indicate any deterioration. I also attach a report by the River Surveyor. The bars below Diamond Harbour are not easy to compare, as the channels shift from one part of the river to another, and the river's variations are of too long a period to form a decided opinion.

2. The return of ships wrecked during the same period is attached; but with regard to groundings, it is only for the last three years that the locality of the grounding has been recorded.

3. I also attach a list showing that five inward-bound ships have been detained below Diamond Harbour for neap tides, and that one vessel has been neaped at Moyapore, outward-bound, during the above period; also showing the amount of detention in each case.

DIAGRAM SHEWING THE MEN YEARS ENDING MARCH 1881.

Statement of ships "neaped" or detained for want of sufficient depth of water during the last three years, as well inward as outward.

NAMES.		DRAUGHT OF WATER.		DATES OF PASSING DIFFERENT STATIONS.					REMARKS.
Inward.	Outward.	Ft.	In.	Atcheepore.	Hooghly Point.	Diamond Harbour.	Mud Point.	Saugor.	
						1878-79.			
Ship *Respigadera* .	......	20	9	20th March	20th March	20th March	16th March	16th March	Neaped at Diamond Harbour.
" *Khersonese* .	......	22	...	4th April	4th April.	4th April.	4th April.	30th March	Neaped at Mud Point.
						1879-80.			
Steamer *City of Khios*.	......	22	2	3rd May .	3rd May .	3rd May .	29th April.	28th April	Neaped at Diamond Harbour.
Ship *Cuba* . .	......	23	9	3rd June .	3rd June .	2nd June .	27th May .	27th May .	Neaped at Diamond Harbour.
						1880-81.			
	Ship *Portia* .	22	9	9th Jan. .	13th Jan.	13th Jan.	14th Jan.	14th Jan.	Neaped on way down at Moyapore.
Ship *Waterloo* .	......	22	2	12th March	12th March	8th March	8th March	8th March	Neaped at Diamond Harbour.
Total—Inward . 5									
Outward . 1									
GRAND TOTAL . 6									

From S. REED, Esq., River Surveyor, to the Port Officer, Calcutta,—No. 42, dated the 5th May 1881.

With reference to your office memorandum No. 1135 of the 28th February last, calling for a report upon the present state of the river Hooghly, more especially of that portion above Diamond Harbour, as to whether it has deteriorated as a navigable river during the past ten years, I have the honour to forward for your information a diagram showing the water over the bars at Moyapore, Royapore, Fultah, and the Eastern Gut, James and Mary's, for each month of the years named, together with a tabular statement showing the shoalest water in each of the channels in use below Diamond Harbour during the same period.

From 1871 until October 1872, when the Bellary was first opened, the following channels were in use:—Bedfords, Dredge, Mud Point, Channel Creek, and the outer Rangafulla. The two former were deep, with nothing under 18 feet reduced throughout. The Mud Point channel was subject to very rapid changes; small detached lumps were constantly forming as well as a bar across the channel with from 11 to 13 feet on it. The Channel Creek channel was narrow but deep throughout. The outer Rangafulla was always in a constant state of agitation; lumps were repeatedly forming and disappearing, rendering the presence of a surveying vessel indispensable; there was also a bar with an average of only 10 feet reduced across it at the upper part, which deteriorated from 10 to 6 feet between July and October 1872, when the Bellary and Huldea channels were opened with 13 feet on the bar of the former; thus the Bellary, Huldea, Jellingham, Dredge, and Bedfords became the route, the use of the outer Rangafulla, Channel Creek, and Mud Point channels being abandoned. The Bellary bar (the only one in the new route) ranged during the years 1873-74-75 between 13 and 11 feet reduced. In 1875 the Bedfords began to deteriorate. A bar of 16 feet reduced having formed, this channel continued to shoal until the opening of the new Eden Channel in 1876, with 16 feet least water throughout. Bedfords having shoaled to 14 feet, was finally closed in 1877. Since 1876, the Eden, Auckland, and Dredge, combined channel, Jellingham, Huldea, and Bellary channels have been in use. The Eden has since improved, and is now a fairly wide channel, with 18 feet least water throughout; the same in the Auckland and Dredge. A bar has, however, formed across the lower part of the Jellingham with 13 feet least water at present. The Huldea Channel has remained fairly steady as far as depth is concerned, an average of 18 feet having been maintained since its opening in 1872. The soundings over the Bellary bar have varied from 10 feet 6 inches to 13 feet reduced, the least water at present on the bar.

The outer channels, with the exception of Saugor Roads, have remained steady. The river below Diamond Harbour is on the whole in a better navigable condition than in 1871. Owing, however, to the constant changes in the sands, forming the limits of the different channels, a temporary obstruction is always liable to occur.

Above Diamond Harbour the seasonal changes occur much as usual, and the river is certainly not in a worse condition than heretofore.

Tabular Statement showing the depths of water in the lower channels of the River Hooghly during the ten years ending 1880-81.

Name of channel.	1871-72.		1872-73.		1873-74.		1874-75.		1875-76.		1876-77.		1877-78.		1878-79.		1879-80.		1880-81.		REMARKS.
	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	
Eden	...	...	...	...	...	...	...	...	...	...	16 0	16 0	16 0	16 0	16 0	18 0	18 0	18 0	18 0	18 0	Eden opened 1876.
Bedfords	21 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	16 0	16 0	14 0	...	...	...	...	...	...	...	...	Bedfords closed 1877.
Auckland	...	...	...	...	...	...	...	...	17 0	18 0	18 0	17 0	17 0	16 0	16 0	17 0	17 0	18 0	18 0	18 0	Auckland and Dredge same channel.
Dredge	21 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	16 0	...	...	...	...	...	...	...	...	...	...	
Jellingham	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	17 0	17 0	16 0	16 0	15 0	15 0	14 0	14 0	13 0	Jellingham opened 1872.
Mud Point	13 0	11 0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Mud Point abandoned 1872.
Huldea	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	Huldea opened 1872.
Channel Creek	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	Channel Creek abandoned 1872.
Bellary	...	...	13 0	13 0	12 0	12 0	12 0	11 0	11 6	10 6	10 0	12 0	12 0	12 0	12 0	10 6	11 0	12 0	12 0	13 0	Bellary opened 1873.
Rangafulla	10 0	10 0	10 0	6 0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Rangafulla closed 1873.

NOTE.—These figures show the shoalest water, or what may be termed the bars in the different channels named.

RIVER SURVEY DEPARTMENT;
The 5th May 1881.

S. REED,
River Surveyor.

List of Vessels lost in the Hooghly during the last ten years.

YEARS.	Names of vessels.	Above Diamond Harbour.	Below Diamond Harbour.	Collisions.
1871-72 . .	*Isabella Brown*	...	1	...
1871-72 . .	*Ocean Chief*	...	...	1
1872-73 . .	*Aral*	...	...	1
1872-73 . .	*Wellesly*	...	1	...
1873-74 . .	None	...	...	...
1874-75 . .	*Grand Duchess*	...	1	...
1874-75 . .	*Evening Star*	...	1	...
1875-76 . .	None	...	...	...
1876-77 . .	*Puritan*	...	1	...
1876-77 . .	*Cowdon Castle*	...	1	...
1877-78 . .	*County of Berwick*	...	1	...
1877-78 . .	*County of Sterling*	1	...	...
1878-79 . .	*Queen Anne*	1	...	...
1879-80 . .	None	...	...	...
1880-81 . .	None	...	...	...
	TOTAL .	2	7	2
	GRAND TOTAL .	...	...	11

List of Vessels grounded below and above Diamond Harbour during the last ten years.

YEARS.	Below Diamond Harbour.	Above Diamond Harbour.	Total.
1871-72	77	No records kept as to the locality.	
1872-73	62		
1873-74	68		
1874-75	49		
1875-76	45		
1876-77	32		
1877-78	50		
1878-79	6	31	37
1879-80	4 } 21	30 } 96	34
1880-81	11	35	46

The 5th May 1881.

(*Extract from Annual Report of Port Officer for 1880-81.*)

The following is a statement of arrivals and departures during the year :—

	STEAMERS.			SAILING SHIPS.			TOTAL.		
	Number.	Gross tonnage.	Net tonnage.	Number.	Gross tonnage.	Net tonnage.	Number.	Gross tonnage.	Net tonnage.
Arrivals . .	506	1,009,052	666,213	478	570,817	554,333	984	1,579,869	1,220,546
Departures . .	510	1,014,483	669,850	505	616,788	598,860	1,015	1,631,271	1,268,710
TOTAL .	1,016	2,023,535	1,336,063	983	1,187,605	1,153,193	1,999	3,211,140	2,489,256

To this must be added 49 pilot, light, and other Government vessels, as also 131 arrivals and 132 departures of Chandballi steamers, and 37 arrivals and 37 departures of steamer *Victoria* to Balasore. Native craft are not included in the statement. This shows a large increase in the tonnage, and a small increase in the total numbers, which are higher than in any previous years, except the two famine years. A diagram is attached showing this clearly, and that while the increase in tonnage is rapid, the increase in the number of ships is nearly stationary. The diagram also shows that the steady increase in average tonnage of each ship continues, and also the large increase in the number of steamers.

The following is the classified statement showing the number of vessels drawing over 21 feet that were piloted inwards and outwards during the year :—

VESSELS.	Above 21 to 22 feet.		22 to 23 feet.		23 to 24 feet.		24 to 25 feet.		25 to 26 feet.		TOTAL.			
											1880-81.		1879-80.	
	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.	In.	Out.
Steamers	27	43	21	86	8	49	...	23	...	4	56	205	39	133
Sailing vessels	45	130	21	57	2	16	...	6	...	...	68	209	85	153
TOTAL . .	72	173	42	143	10	65	...	29	...	4	124	414	124	286

This shows that the ships of large draught visiting the port are increasing. In 1878-79 the number both "in and out" was only 382, and last year 410 against 538 this year. This does not indicate any deterioration of the river as a navigable stream.

From W. D. BRUCE, Esq., to the Vice-Chairman to the Port Commissioners,—dated 9, Victoria Chambers, Westminster, 15th March 1882.

I find among the papers submitted to the Commissioners at the 354th meeting a letter from the President of the Committee on Docks at Diamond Harbour, in which the Port Commissioners are requested to answer a series of questions relating to the Hooghly and the accommodation for the trade of port now available in Calcutta. Most of the questions can best be answered by the pilots and merchants, but there are two (10 and 11) which, it seems to me, the Port Commissioners are in the best position to answer; and with the view of assisting them in the discussion of these questions, I trust they will excuse my submitting to them the views which I now hold on this important subject. During the last twelve years that I have been connected with the Trust, the subject of port improvements has been constantly before my mind, and I feel now that I can speak with some confidence on the subject.

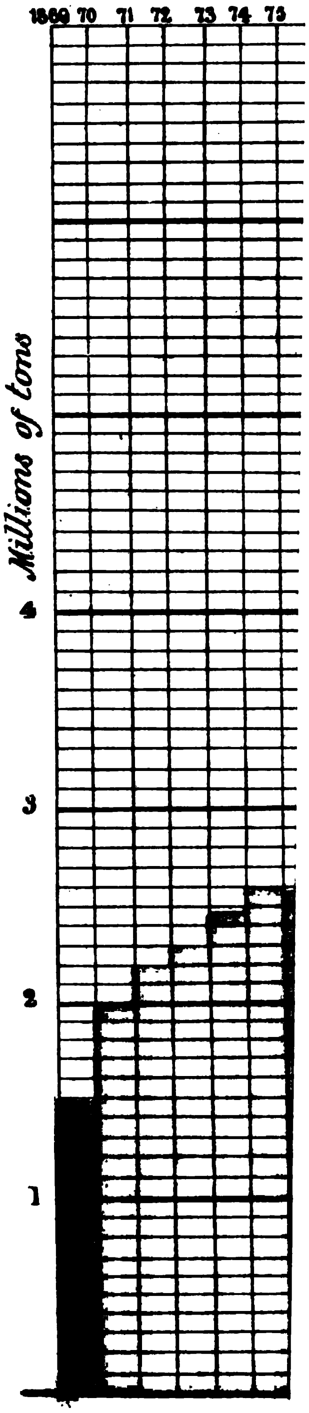
The first question (No. 10) runs as follows :—

> "Having in view the probable increase of traffic on the Calcutta side of the river on the completion of the railway bridge over the Hooghly, do you think that the space now at the disposal of the Port Commissioners will be sufficient for wharfage and general accommodation?"

I am of opinion that it will not. But the present accommodation can be considerably increased, and will be used by a certain class of vessels, so long as they can get up the Hooghly to the Commissioners' wharves.

DL

Total tonnage shew
omitting the famine year



To increase the present accommodation I would, on the completion of the new railway bridge, remove the floating bridge from its present site to one immediately to the north of the Neemtollah Burning Ghât.

This would enable the Commissioners to lay down a large number of new moorings immediately abreast of the town and the East Indian Railway Company's premises in Howrah, and save many vessels from the great inconvenience they are now put to by mooring them in Kidderpore and Garden Reach.

There would then be no obstruction between the shipping and the docks in Howrah, and vessels would be saved the expense to which they are now put when it is necessary for them to dock. On the completion of the railway bridge the bulk of the traffic will come direct to Calcutta, and the floating bridge can then be moved from the Armenian Ghât site to the site I indicate without inconvenience to the general public or the railway traffic.

The railway pontoon at Armenian Ghât can also be removed from its present site either to Howrah or to a site in front of the Commissioners' workship at Meerbahar Ghât, if it is considered necessary to maintain the ferry in this position.

Another jetty could then be erected to the north of No. 1 Jetty, and the whole frontage of the East Indian Railway Company in Howrah would be available for jetties should it be deemed advisable to erect such jetties for the loading of coal or other exports brought down by the railway for direct shipment. If an export trade in coal ever arises, the coal could be as easily shipped over jetties in this position as in the proposed docks at Diamond Harbour. To the south of the jetties, or between No. 8 and Chandpal Ghât, the accommodation for boat traffic is at present limited, and could not be encroached upon for the use of sea-going vessels without causing great inconvenience in the shipment of goods by cargo boats. The purchase of the Chandpal Ghât Pumping Station and the extension of the inland vessel wharf to Babu Ghât will afford a certain amount of relief. But I can see no good reason for confining the boat traffic within these limits; the boat wharf might be extended, without any inconvenience to the public or encroaching on the drive, to the point opposite the north end of the carriage stand at the Eden Gardens, and if this were allowed, another jetty might be constructed to the south of No. 8. This, with a new jetty north of No. 1, would give 10 jetties for sea-going vessels, at eight of which vessels of 400 feet in length could be discharged.

This in my opinion is all that can be done to extend the accommodation on the Calcutta bank of the river abreast of the town, and it will not, when completed, provide for more than 250 or 260 general cargo vessels annually.

No wharfage accommodation can be provided for salt ships or to vessels employed in the coasting trade, and there is practically no river frontage available to provide accommodation for the increase in the trade of the port generally, except at Garden Reach, which is inconveniently suited for communication with the business quarters of Calcutta.

The next question then arises—

> "If not, can you suggest any means of supplying the deficiency otherwise than by constructing the proposed docks?"

Docks at Diamond Harbour have often been proposed, but last, I believe, by Mr. Simms nearly 30 years ago. He went fully into the subject, but nothing came of it, and it is my opinion that if they are carried out now they will prove as great a failure as Port Canning.

All experience has shown that it is most difficult to move a great and established centre of trade, and also that while it is possible to bring ships within easy distance of the merchants, the merchants won't move to the ships. It will, no doubt, be argued that it is not intended to move the merchants from Calcutta to Diamond Harbour. The ships will stop there, but the goods are to be delivered by the railway in Calcutta, just as they are now delivered at the jetties; but such a system won't work. The merchant or his shipping clerk must be near the ship and in constant communication with those on board. Disputes as to breakage, damage by water, and short delivery are constantly arising, and have to be settled between the captain or agent of the ship and the consignees of the goods, and it would, it seems to me, be impossible for any cargo importer or exporter of goods to work with ships at Diamond Harbour without having an office on the spot, which would lead to extra expense, division of establishment, and interfere seriously with the conduct of business.

I have no doubt such reasons will be considered trivial objections to the scheme, but I have during the last twelve years seen so much of the worry and annoyance these disputes cause even when working ships directly under the eye of the merchants, and I am certain they would lead to such serious detention or loss if the proper parties were not on the spot to settle them, that I feel convinced no ship will stop to discharge or load at Diamond Harbour so long as she can get up the Hooghly to Calcutta, even at some little risk to herself. The question then arises, how can they best be provided with proper accommodation in Calcutta. The space available for moorings within easy distance of the business quarter of the town is limited, and I have already shown that only a very slight increase in the length of the wharves for sea-going vessels can be made on the Calcutta bank near the town without encroaching on the maidan. Jetties or docks in Howrah will never answer when the East Indian Railway runs into Calcutta. The great bulk of the East Indian Railway traffic will leave Howrah when the bridge is completed, and whatever is done to facilitate the landing and shipping of goods must be done in connection with the railway system on the Calcutta bank of the river.

The space available for jetties or wharves on the river bank being limited, it seems quite certain that docks must sooner or later be constructed if the ships are to be brought within easy distance of the merchant offices. Many sites for docks have been proposed and reported on from time to time, but the site which seems to offer the greatest advantage, and which has been reported on most favourably, is that at Chitpore. Any site in Calcutta is, however, now objected to on the ground, apparently, that the James and Mary shoal will prevent vessels of greater length and draft than those now running to come up to Calcutta, and that, looking to the probable increase in the size of vessels trading with Calcutta, docks for the accommodation of such vessels should be constructed at Diamond Harbour.

I quite agree with the proposers of this scheme in thinking that in considering the question of extensive improvements for the shipping trade of Calcutta, the dangers and shoals of the Hooghly likely to lead to any interruption of traffic should be taken into account. But I cannot agree in the opinion that by establishing docks at Diamond Harbour, the worst shoals or the greatest dangers in navigating the Hooghly will be avoided. The answers of the pilots to the first nine questions will, I hope, have convinced the Committee that the most changeable shoals in the Hooghly, and those most likely to interrupt traffic, lie between Diamond Harbour and the sea. Between Calcutta and Diamond Harbour the Hooghly is now practically in the same state as it was a hundred years ago. Changes take place annually in the James and Mary sands, but they are well understood, and pilots can guard against them. Below Diamond Harbour, in the Rangafulla channels, the case is very different. These channels are constantly changing, and in 1879-80 the Bellary Channel—the only channel by which vessels could cross these sands—was rather worse than the James and Mary shoal. Hitherto it has generally been found that as one channel across these sands closed up, another opened out; but a study of the charts showing the great and constant changes that take place between Culpee and Mud Point should, I think, convince the Committee that the closing of one channel need not necessarily be immediately followed by the opening of another, and that at any moment a bar might be thrown up which would cause a serious delay to (if it did not entirely prevent) the crossing of deeply laden vessels. The evidence collected by the Committee of 1853-54, and again by Mr. Leonard in 1864, all go to show that the chances of interruptions to traffic are greater below than above Diamond Harbour. The Committee that sat in 1854, in their report, divided the Hooghly channels into three classes: 1st, the stationary; 2nd, the fluctuating; and 3rd, the deteriorated; and then go on to say—"The portion of the river between Calcutta and Culpee may be considered to embrace all the channels of the first class, for though within it are found the dangerous and variable sands that lie between Fisherman's Point and Diamond Harbour, and the minor obstacles at Royapoor and Moyapoor, yet there is an apparent permanence of character in the remainder of that section of the river which is not found lower down.

"The channels between Culpee and Kedgeree constitute the second or fluctuating class, and their changes are constant and rapid both in character and position." Below Kedgeree the report goes on to say that "the preponderance of evidence decides that they have deteriorated."

In the report submitted by Mr. Obbard, River Surveyor, on the condition of the Rangafulla Channel between 1755 and 1836, he says—"December 1796. Outer channel so bad that ships of draught cannot use it, and inner so narrow that they cannot be laid across it to drop. Master Attendant therefore recommends that none of the Company's ships be brought above Kedgeree."

It would be a serious matter if such an interruption to traffic occurred now. But the use of steam renders it possible for vessels to navigate narrow channels which without steam they dare not attempt. It would not, therefore, now necessarily follow that if the channels got into the same state that they were in 1796 there weuld be any interruption to the traffic, but I think it is a very significant fact, bearing on the general condition of these channels, that whereas in former years vessels of any draught could be brought up without steam, the pilots are now prohibited from taking any vessels drawing more than 21 feet either up or down the river without a tug.

Bearing all these facts in mind, it appears to me that the first question to be decided when considering the question of improvements on the large scale now proposed is whether all such improvements are to be left entirely at the mercy of the changing channels of the

Hooghly, or whether it would not be advisable to have a second string to our bow and to connect Calcutta by a ship canal with the Mutlah. I am decidedly of opinion that the latter is the proper and wisest course to adopt. If docks are now to be constructed to meet the great increase in trade, which it is anticipated that the construction of new railway bridge will bring into Calcutta, such docks should be in a position to communicate either with the Mutlah or the Hooghly.

Docks at Diamond Harbour are just as likely to be cut off from communication with the sea as the Port of Calcutta, and this fact alone is to my mind a sufficient reason against their construction, even were it probable that they would be used by vessels with cargoes for Calcutta, which I feel confident they would not so long as such vessels, even at some risk to themselves, can get up to Calcutta.

My suggestion, then, to supply the deficiency in space otherwise than by the proposed docks at Diamond Harbour would be (1) to dredge a ship canal of the same section as the Suez Canal from the Mutlah to Sealdah; (2) to excavate a large dock on the east side of the railway in the position shown on the tracing which accompanies this letter; and (3) to connect this dock with the Hooghly by a cut joining the river at Chitpore to the north of the present entrance to the canal. Vessels could then enter the dock either from the Hooghly or the Mutlah, and take berths either in the dock or at the jetties. The depth of water in the canal should be sufficient for vessels drawing 24 or 25 feet. Vessels could then proceed to sea by the Mutlah at any time of tide, there being sufficient water at all times from a point on the Mutlah about five miles below Port Canning (where I propose the canal to start from to the sea).

To properly carry out this scheme, the Calcutta canals from the entrance lock at Dhappa to Chitpore should be made over to the Port Commissioners, and form part of the Port of Calcutta. The Commissioners might recoup Government the expenditure recently incurred in improving the canals, and in return charge all boats discharging in the canal the same wharfage fees as are now charged on the inland vessels' wharves in the Hooghly.

Boats that now pass through the canal to discharge on the river wharves pay all the canals' dues and the port dues as well, and there seems no good reason why the boats discharging in the canal should not pay for the facilities they there receive. The revenue at present derived from the canals, and which is really paid for keeping open the communication through the Sunderbuns, would still be charged by Government and be available for improving the canals and channels which would remain under the Irrigation Department. The locked portion of the canal would then form part of the dock system I propose, and there would be free and easy communication between the boats in the canal and the vessels in the dock, as the water in the canals and in the dock would all be at the same level.

This is an outline of the works I would suggest to meet the future requirements of the trade of Calcutta. The proposed dock would be in the most convenient position for railway traffic and within easy distance of the merchants' offices, while the construction of the canal would render Calcutta for ever independent of the freaks of the Hooghly.

What the actual cost of the docks would be I am not in a position to say, but they can be constructed in the position I have indicated as cheaply as at Diamond Harbour, while the actual outlay of capital on all the buildings and accessories which it would be necessary to construct at Diamond Harbour would be far greater than in Calcutta, where warehouses, water-supply, gas, and drainage already exist.

The cost of dredging the canal would be, I estimate, about £750,000. Interest on this sum at 4½ per cent. would be £35,750; and if to this is added £12,000 for annual repairs and dredging, the total cost of maintenance would be 4½ lakhs per annum. The saving in pilotage alone by the Mutlah route would cover a great part of this, and as the trade of Calcutta is gradually becoming a steam trade, there is practically very little necessity to consider the question of towage in connection with their proposed works.

The construction of docks would, I believe, tend very much to increase the number of steamers. If the Commissioners had proper arrangements for the discharge of salt steamers, they could then come out laden with salt. At present they cannot, as salt has to be discharged into boats and as the consignee requires it. So far the Commissioners derive no revenue whatever beyond mooring hire from any vessels trading to the port, except those bringing general cargoes. With a dock and greater facilities for loading vessels direct from the railway wagons, they would at once secure the landing and shipping charges from vessels employed in the salt trade and on the Coast and China trades. There is therefore, it will be seen, ample room for a great extension of improved appliances without in any way encroaching on the revenue derived from improvements already constructed. But such further improvements should be made where they will afford the greatest convenience to those employed in the trade of the port, and where they can form part of, and utilize to a great extent, the facilities which have already been provided—not in a position where, if they are used at all, they will be in opposition to the works already constructed, and where, I believe, they would never be profitable unless a great part of the trade of Calcutta, and the merchants who conduct it, removed to Diamond Harbour.

From COMMANDER A. DUNDAS TAYLOR, late I.N., Superintendent of Marine Surveys to the Government of India, to the President of the Committee on Docks at Diamond Harbour,—No. 1, dated Calcutta, the 8th March 1882.

I have the honour to acknowledge receipt of your letter dated 21st January 1882. Having carefully read the 38 questions submitted for my opinion, I consider only one paragraph—the 9th—claims any remarks from me. This paragraph seeks information on "any points in connection with the navigation of the Hooghly which affect the question of docks at Diamond Harbour, either for or against the scheme."

I beg to observe that your letter under reply does not indicate the chosen position for the proposed docks; but this is a question of great importance. Diamond Harbour and the mouth of its creek are a dead lee shore in the southerly moonsoon, and there is little slack water at turn of tide.

In my opinion the site for docks could only be definitively settled by a Committee composed of both nautical and engineering elements, including pilots and practical men who have docked ships either here or at Bombay Prince's Dock. This Committee should assemble at Diamond Harbour for two or three days during boisterous weather and at strong spring tides in the month of July.

From R. M. DALY, Esq., Branch Pilot, to the President of the Committee on Docks at Diamond Harbour,—No. 1, Albert Road, dated the 3rd April 1882.

Having been requested by Mr. Wawn to write down my opinion as to the feasibility of docking and undocking ships and steamers at Diamond Harbour (in the event of the new proposed works being carried out), I have the honour to state that, as far as I am able to judge, there would always be considerable difficulty experienced in docking large ships during the height of the south-west monsoon, as Diamond Harbour is a dead lee shore. I fancy each operation with the class of ship that is now being built for the East India trade would require the services of one or two small tugs, such vessels as are used in the Suez Canal, to assist the large Messageries steamers when entering the Bitter Lakes, &c.

Diamond Harbour showing such a broad expanse of water, there might often on very stormy days be considerable difficulty in making fast such tugs alongside, which I fancy would be the only way of ultilizing them.

I do not think, from the plan of the docks that I have seen, that more than four or five ships could be docked at a time, as the time of tides allowable for such operations could not exceed more than two hours each day.

Another mode would be by buoys moored outside and hauling the ships by lines from buoy to buoy. This on windy days would always be attended with great risk, as it would be a slow process, and ships' spars hold a deal of wind, and should it ever happen that a ship came to roll over a buoy, it might be the cause of her total loss.

With regard to docking large steamers, I daresay the operation would be a much easier one, as they would always be assisted by the aid of their own steam.

I am of opinion that the undocking of either sailing ships or steamers would be comparatively easier, but on windy or stormy days I fancy even this work would be attended with risk and danger.

From S. R. ELSON, Esq., Senior Master Pilot, to the President of the Committee on Docks at Diamond Harbour,—No. 112, Circular Garden Reach Road, dated Calcutta, the 11th April 1882.

I have the honour to acknowledge the receipt of your letter dated the 1st instant, and in reply thereto I beg to say that I did not allude to question 9 of Mr. Reynolds' letter, because I considered my replies to some of the other questions contained matter tending to show that I see nothing against the proposed docks at Diamond Harbour, excepting that the site of the entrance would, I think, be in a better situation, as regards eddies, if it was higher up the river in a position between the Custom House and Port Office.

As regards the entrance to the docks being on "a dead lee shore," I do not think that can be considered to be a very formidable obstacle, as a vessel anchored off, or hauling into, it could all the more easily be swung 'end on' to it, the wind assisting her, which it would not do if the wind was blowing across it and tending to swing a vessel right across. However, I should think some of our Harbour Master Assistants, who have had much experience in hauling vessels in and out of dock, could render the Committee valuable information on this point. Another thing is that it is not always blowing hard or so hard as to cause any delay in moving vessels in or out of the dock, and when it is blowing so hard I should think it would be during such weather that vessels would not put to sea or be able to find their way into Saugor, such as in the cyclonic bursts of July and August; and on the whole I believe the scheme of docks at Diamond Harbour, in view of the fast increasing size and length of vessels all over the world, is a good one for the prospects of the port of Calcutta, and that the site is well chosen (of course if the entrance were, say, a quarter of a mile higher up, or above the creek, which I have been told is the proposed entrance).

Second Letter.

From S. R. ELSON, Esq., Licensed Senior Master Pilot, to the President of the Committee on Docks at Diamond Harbour,—dated Sandheads, the 26th April 1882.

Herewith I forward an extract from the River Surveyor's report which I think will be of interest to your Committee, as it shows how much the channel of the river is apt to be contracted above Diamond Harbour at times, and, therefore, how much will be avoided that is dangerous to the navigation of large vessels if the proposed docks at Diamond Harbour are constructed:—

Extract from River Surveyor's Report, dated 3rd March 1879.

"The channel from Noorpore Point to abreast the Upper Nun Buoy is very narrow (500 feet wide), the deepest line being Noorpore mark midway between No. 4 track and Hooghly Point Semiphore. The patch to the westward of the two red Nun buoys is very steep and shoal, having only four feet reduced in some places, and there is not more than 10 feet reduced in the line of the two red Nun buoys. Vessels meeting, or bad steering vessels shearing, must be careful here, as there is no room to borrow to the westward, and a mud flat extends a little way out from the shore to the eastward."

The above narrow channel is about one mile in length, and is subject to strong eddies on the spring tides, being just above the James and Mary's eastern gut.

From Messrs. GILLANDERS, ARBUTHNOT & Co., to the Secretary to the Committee on Docks at Diamond Harbour, Writers' Buildings,—No. 93, dated Calcutta, the 4th April 1882.

We duly received the communication from the President of the above Committee, dated 21st January last, submitting for reply a series of questions bearing on the subject of docks at Diamond Harbour. We must express our regret that we have not sooner been able to find time to attend to the matter, and fear that the expression of our views now may be too late to be of service. We attach, however, to this (as requested) replies to such of the questions as seem to come within the range of our experience. It is difficult to form a clear opinion on the subject the Committee are enquiring into in the absence of certain special information, which will no doubt be in the possession of the Committee, and such an expression of opinion, we are aware, is not solicited; but we wish to add that, generally speaking, we strongly deprecate any scheme on a scale that might tend to remove the centre of shipping to a place so far distant from Calcutta (the base of the commercial operations of the city) as Diamond Harbour, though, should the scheme not contemplate more than the introduction there of a small and useful adjunct to the advantages of this port, we should be disposed to approve it. It would, we think, however, be preferable to first provide increased accommodation within the limits of the port, and, if within the range of engineering skill and practical finance, to permanently improve the navigation of the river, especially between Diamond Harbour and Calcutta.

From Lieutenant A. W. **Stiffe**, I.N., Port Officer, Calcutta, to the President of the Committee on Docks at Diamond Harbour,—dated Calcutta, the 30th March 1882.

In compliance with Mr. Wawn's verbal wish, I send you the following notes.

As to room at Diamond Harbour for anchorage, there is unlimited room. Of course a larger number of ships will occupy a greater length of the river than a smaller number; that is all that can be meant by stating there is no room.

As to the question of docking or undocking during the monsoon or southerly gales, I can understand that there may be days in the year when the wind is so strong it would be difficult to moor ships at all. It does not appear to be an insuperable difficulty, and no doubt will be found less than anticipated. I remember the same difficulty was anticipated with the Bombay docks.

At the same time I think it is to be regretted that no nautical man was appointed a member of a Committee on so very nautical a question. I should have been prepared to suggest a site about three miles higher up than Diamond Harbour *creek*, near Hospital Point, as being in smoother waters.

I think it is possible there may be certain days in the year when vessels could not be taken out or in safely; but I think, as a rule, it will be found possible to dock ships or undock them without difficulty at the proposed site in the creek.

From Captain C. J. **Wilkinson**, Superintendent, Peninsular and Oriental Steam Navigation Co., to the Secretary to the Committee on Docks at Diamond Harbour, Writers' Buildings,—No. GN50—82, dated Calcutta, the 10th March 1882.

I am in receipt of your President's letter regarding the proposition for constructing wet docks at Diamond Harbour, and have much pleasure in replying to those questions appertaining to my own position as Agent for a Steam Packet Company.

I have avoided giving answers to those that are purely mercantile; also to those which can be better replied to by the pilotage staff.

Looking at the matter from a shipowner's point of view, I consider the docks would be of immense advantage, if the cost of construction would not raise the charges on shipping higher than they are at present. There would be a saving of some few hours on the inward passage, and at least 24 hours on the outward with the greater immunity from risk of an accident to a long ship rounding Hooghly Point on a strong flood tide, or in going down the river during the freshets when she has very often to anchor at Fisherman's Point. This latter can show a long list of disasters.

It has been sufficiently proved to the satisfaction of all shipowners that the larger a ship is built, with reference to the trade she is employed in, the greater will be the profits in proportion to the capital expended; but whilst the present risks of navigation exist in the upper part of the Hooghly, there must be a restriction to the size of the ships beyond what may be considered the limit of the requirements of the trade, and I am of opinion that this limit has already been reached by the present ships of nearly 400 feet long and 24 feet draught.

This limit is not at present influenced by the Suez Canal, as a vessel can safely pass through at a draught of 25 feet 6 inches.

From Messsrs. **Gladstone, Wylie** & Co., to the President of the Committee on Docks at Diamond Harbour,—dated Calcutta, the 22nd February 1882.

We have now the honour to wait on you with our answers on the various questions relating to the navigation of the Hooghly, and to the construction of docks at Diamond Harbour.

In sending you these answers we desire to offer a few remarks on the subject.

The scheme is one which we do not think will meet with success. Half measures are generally ineffectual, and the dock accommodation, as at present sketched, would not even be large enough to suffice for half the tonnage that is generally in Calcutta. The difficulties to shippers would therefore be doubled, and many shippers would have to keep up an establishment at Diamond Harbour as well as at Calcutta. The attempt to make Port Canning the port of Calcutta, though ineffectual, had, we think, many more advantages than the present scheme in regard to Diamond Harbour. The avoiding two difficult points of the river, when there are four others below Diamond Harbour as difficult, if not more so, would not be worth the expenditure of so large a sum of money, for we think it would require considerably more than a million sterling to transfer the shipping trade of this port to Diamond Harbour.

We also think that past experience would show that the effects of a cyclone are felt much more severely at Diamond Harbour that at Calcutta.

The cargoes of all vessels coming into the Hooghly must come to Calcutta, and there can be no doubt that it is greatly to the advantage of the importer, as well as the ship, that the goods should be landed at their destination without any transhipment when this can be done. The same would apply to exports, and we are sure that exporters would prefer putting their cargo on board a vessel lying in Calcutta, rather than run the risk of sending it down to Diamond Harbour where it might be shut out, and so cause great complications between the shipper and ship agent. Moreover, it seems to be intended to charge the ship with the expense and risk of carrying both import and export goods between Diamond Harbour and Calcutta by rail—a charge which no shipowner would willingly agree to; and if, with docks at Diamond Harbour, ships had the option of proceeding to Calcutta, we believe that nearly all vessels would continue to come on to Calcutta, for, in our opinion, the advantages that seem to be offered by this scheme would be in no way commensurate with the very much heavier expenses that would be incurred if ships had to discharge at Diamond Harbour and forward their cargoes. For if such a sum as proposed, *viz.*, one million sterling, be expended on the building of docks, there must, as a matter of necessity, be heavy charges levied on the ships making use of the docks, and when to this is added the railway freight between Diamond Harbour and Calcutta, we feel convinced that a port at Diamond Harbour would be more expensive to shipping than Calcutta is at present, and shipowners now complain of Calcutta as being one of the most expensive ports in the world.

There is one practical objection to the scheme which seems to have been entirely overlooked, and that is, that the proposed position of the docks is on a dead lee shore during the south-west monsoon, when it will seldom be possible to dock and undock vessels with safety.

Of late years there has been a very considerable increase in the size of vessels coming to Calcutta, yet during that time there have been fewer accidents in the river than previously, and the dangers of the James and Mary's seem to have been reduced to a minimum. If, however, there should be any chance of the channels silting up, we think that by an expenditure of a tithe of the sum proposed to be spent, the channels of the river could be kept open and its navigation be rendered quite safe.

We are of opinion that the port of Calcutta should remain where it is rather than have it, or any portion of it, removed to Diamond Harbour.

From Messrs. RALLI BROTHERS, to the Secretary to the Committee on Docks at Diamond Harbour, Writers' Buildings,—No. 9, dated Calcutta, the 16th February 1882.

We have the honour to submit herewith our remarks on the above subject in answer to the circular letter under date the 21st January last.

To the several questions therein we are in a position to answer the following only, *viz.*,—

(For replies to questions, see pages 120 to 137.)

In conclusion, we beg to submit that, generally speaking, the proposed scheme, far from affording any advantage, would tend to cause many inconveniences both to importers and shippers.

From Messrs. HOARE, MILLER & Co., to the Secretary to the Committee on Docks at Diamond Harbour,—dated Calcutta, the 22nd February 1882.

We find many of the questions contained therein beyond the range of our practical experience; those which have reference to pilotage can, however, be replied to fully after we have had an opportunity of conferring with the pilots who usually take charge of our steamers trading to this port from the United Kingdom, whose opinion would be valuable.

We have not had an opportunity as yet of discussing with experts the question of insurance risk between Diamond Harbour and the Calcutta Port. There can be no doubt as to the risk attending this portion of a vessel's voyage, but we doubt any tangible reduction ensuing in the rates of premia on either the hulls of vessels or on their cargoes from the proposed docks. The advantages to vessels, which we should expect from the proposed docks, would, in our opinion, arise out of, first, saving of time; second, coal; third, greater scope for size and draft; the latter advantage affecting also the interest of the Calcutta trade generally.

To the other questions we propose to reply in a general form; we cannot answer each query specifically as made.

From the form of the question we assume that the " space now at the disposal of the Port Commissioners " refers to " space " on the left or Calcutta side of the river.

In reply, we do not think the space will be sufficient for the traffic.

As a matter of practical experience, whatever the " space " may be, the accommodation or arrangement of the port is not sufficient for its present export and import business, and if the transference of the station for the receipt or despatch of cargo from Howrah to Calcutta leads to an increase of the general trade of the port, the want of accommodation will be more apparent than ever.

The labours of the Port Commissioners seem so far to have been mainly directed to facilitating imports, and they have been very successful. They have rendered easy the increase in the import trade that has taken place within the last ten years; but concurrently with imports the export trade has grown also, without, however, having had corresponding facilities provided for it to those that have been provided for the discharge of imports.

Amidst the many advantages which the jetties have conferred on the trade generally, but chiefly on import trade, there has been this disadvantage, that they have interfered with the boat-owner's business. The jetties have disorganized the private discharging and loading arrangements of the port without having so far furnished a complete or perfect substitute.

For practical purposes the jetties are sufficient for the import trade, almost all the vessels which enter from United Kingdom with general cargoes can be discharged rapidly at the jetties, and even in time of extra demand for space, steamers can load their export as rapidly as they discharge their import cargo; but this only refers to general or " Calcutta assorted " cargoes. It does not include whole cargoes outwards.

The export cargo from Calcutta is bulkier than the import cargo. With very few exceptions, every vessel that clears from Calcutta clears full. On the contrary, many vessels, notably steamers, enter in ballast. Now, it seems to us that the arrangements of the port stand as if just the contrary were the case; vessels can discharge quickly, and we think cheaply; whereas for loading they mainly depend on cargo boats.

During periods of excitement in exports, such as periodically occur, the cost of putting cargo on board vessels at moorings often becomes enormous. We have known the hire of cargo boats of 25 tons capacity, which is normally R6 per day per boat, advance to R120, and remain at from R40 to R60 for weeks together. This is as if the jetties were in times of pressure to raise their rates at will from 400 per cent. to 600 per cent. The export trade is not a steady trade. Periods of excitement occur chiefly in the bulky staples.

(For replies to questions, see pages 121 to 138.)

General.—We doubt very much that it would pay to construct the proposed dock at Diamond Harbour. We believe that liner steamers, which are full-powered and steer easily, would almost always prefer to discharge their assorted cargoes in Calcutta, and equally that they must load there. The chief, if not the only, customers of the docks would be such salt ships as might arrange to discharge there, and such " whole cargo" carrying steamers as might arrange to load there.

We believe that a very much smaller sum of money than it would take to build the docks could be most usefully employed to improve the navigation of the Hooghly, and to develope the appliances in the port itself. It is not space that is wanting in the port, but appliances and arrangement.

Roughly speaking, we would adopt the Howrah side for exports and the Calcutta side for imports. The East Indian Railway should bring down to Howrah the seed and wheat from up-country. There should, along the right bank of the river, be warehouses suitable for storing, examining, cleaning, and packing seed and wheat. If the East Indian Railway crosses the river at Hooghly, and enters the heart of Calcutta, importers would have the greatest facilities for receiving their piece-goods on the left bank of the river, and of despatching them from a convenient station close at hand; while, if the present Howrah station and the newly acquired foreshore on the right bank of the river are remodelled and built on or adapted for exports, we think as much will have been done to make Culcutta equal to the possibilities of her trade as the nature of her circumstances will permit of.

From G. H. SIMMONS, Esq., Secretary to the Commissioners for making Improvements in the Port of Calcutta, to the Secretary to the Committee on Docks at Diamond Harbour,—No. 126, dated Calcutta, the 15th April 1882.

I am directed to forward herewith, in original, a letter addressed to Mr. W. D. Bruce from Mr. J. R. Wells, a Branch Pilot, now on leave in England, forwarding his answers framed by the Committee on Docks at Diamond Harbour.

From JOSEPH RICHARD WELLS, Esq., Branch Pilot, to W. D. BRUCE, Esq.,—dated London, the 23rd March 1882.

In forwarding my reply to the questions submitted to me for an opinion, I am afraid I have not been able to answer them so fully as I could wish; each question contains matter for very serious consideration: the first one alone embraces a history of the navigation of the Hooghly, past and present, notably since the opening of the Suez Canal; but doubtless, when the numerous opinions are at hand, reviewed as a whole, there will scarcely remain any question unanswered, and will leave on record a sufficient expression of opinion as will enable the Committee to come to a decision as to the advisability of accepting or rejecting the scheme now in contemplation.

I cannot at present see that the establishing docks at Diamond Harbour will in any way secure the permanent navigation of the Hooghly, when, as expressed in my reply to question No. 1, the serious obstacle being in the event of the Gasper Channel decreasing in depth, which once was the case, and which may re-occur at any time, although now and for some years past it has remained so unexceptionally favourable for the heavy draught vessels now trading between Europe and Calcutta.

From W. H. GRIMLEY, Esq., Offg. Collector of Customs, Calcutta, to the President of the Committee on Docks at Diamond Harbour,—No. 876, dated Calcutta, the 7th March 1882.

I have the honour to acknowledge receipt of your letter, dated 21st January last, forwarding for replies a set of queries, with reference to a proposal to construct deep water docks at Diamond Harbour; and in reply to state as follows:—

(For replies to questions, see pages 109 to 140.)

It has been suggested to me that the excavation of a ship canal, with about 300 feet waterway, with an intermediate basin, if necessary, for crossing vessels, somewhat on the same principle as in the Suez Canal, across the country between Diamond Harbour and about Fisherman's Point, as the crow flies, would be a surer undertaking and much more likely to succeed than the scheme for providing docks at Diamond Harbour.

Office Note by Colonel S. T. Trevor, R.E., Joint-Secretary and Chief Engineer, Bengal Public Works Department, on the Report of the Committee on Docks at Diamond Harbour.

Mr. Robert Steel, who was a member of the Committee till he went to England, has returned, and at my request has kindly furnished me with a note of his opinion, which I put up with this. Of the two alternative projects—docks at Diamond Harbour or canal to the Mutlah—he prefers the latter, even if it should cost twice as much as the former. But he thinks both schemes premature, and would prefer to see an attempt made to extend the existing accommodation of the port. He would move the bridge higher up the river, and extend the jetties in that direction first, and afterwards in the other direction along the *maidan* frontage. He would go to the length of removing Fort William itself, if it presented any obstacle to the extension of the port. This idea of sweeping away Fort William, if necessary, to make room for the port, seems a little startling at first, but I remember it was suggested long ago—I believe by Sir William Mansfield, when he was Commander-in-Chief.

2. Mr. Keswick is also of opinion that the accommodation in the port may be doubled within the existing limits, and proposes that steps should be taken to ascertain this definitely before proceeding with any scheme for docks elsewhere.

3. Mr. Morrison's view of these proposals for increasing the accommodation for shipping without leaving the present limits of the port is that "they deserve careful consideration, but are open to the serious objection that they leave untouched the delays and dangers of the Hooghly." He much prefers the Mutlah Canal scheme to that of docks at Diamond Harbour, and has recorded his arguments in favour of the former and against the latter, which will be found at pages 71 and 91.

4. In the *Englishman* of the 2nd August, put up herewith, is a report of what is said

by Mr. Miller, as President of the Chamber of Commerce, regarding the project for docks at Diamond Harbour. He spoke as follows:—

> "The experiment would unsettle our trade and add to the current expenses of working it. In this view there would appear to be general agreement amongst merchants: but the proposal is still in its infancy; and remembering, as many here must, the strong opposition which existed to the work of the Port Commissioners on the first establishment of that body, I would venture to think we may prudently await a further development of the views of the professional advisers of Government before pronouncing definitely on it or actively opposing the proposal that has been suggested. It is possible that a wet dock at Diamond Harbour might prove convenient for salt ships to discharge, and for ships and steamers to load cargoes of jute and seed and wheat; and if the undertaking could be commenced on a small scale and allowed to grow with the development of trade, it is conceivable that it may prove the best remedy for our present congestion. It is still in embryo, and in view of the great increase that is yearly being made in the size and capacity of steamers, and of the difficulty of navigating them up to Calcutta, I do not think we should condemn this proposal too hastily. Still it appears to me that it would be better to make the most of what we have got before venturing on these gigantic engineering feats, and I hope the mercantile community will be made aware, before it is too late, of the decision of Government, when one is arrived at, and again have an opportunity of forming an opinion."

5. These views may, I think, be taken to represent the opinion of the mercantile community generally, and they amount to this, that there is a strong reluctance to any separation or removal of the port from the neighbourhood of the merchants' offices in Calcutta. In deference to this opinion, I think the Port Commissioners should be asked to submit a full and detailed report and estimate, showing exactly what can be done to increase the accommodation within the limits of the port, what it will cost, and how far it will meet the altered circumstances of the traffic when all the railways are centred in Calcutta.

6. But if we are to be content to go on as we are, and merely expand existing arrangements, there can be no doubt that we shall never succeed in making Calcutta a cheaper port; and that is perhaps the thing most to be desired. In much of the produce exported—jute and wheat, for instance—the margin of profit is very small, and the very existence of the trade depends on the cost at which such produce can be delivered at the ship's side, and on the charges for freight. The existing arrangements of the port, under which it is impossible to deliver produce at the ship's side otherwise than by the employment of intermediate agencies, and after much handling and carting and boating, are about as expensive as can well be imagined. The port itself is approached by 120 miles of extremely difficult river navigation, which involves a very heavy expense in pilotage and detention. These are the grand drawbacks of the port and the main causes of its expensiveness. By merely expanding existing appliances we do not touch them. We cannot hope to get a harbour like Bombay on the sea-coast, but still we can do something to mitigate the present disadvantages. We can reduce the detentions and dangers of the river navigation by half if we build docks at Diamond Harbour, so as to enable ships to terminate their voyage there. We can extend the railway right into the docks, and build proper warehouses, with suitable appliances for lifting and handling goods on the railway, so that every possible facility and economy can be afforded in the treatment of goods up to the point of shipment. In this way, and in this way only, it appears to me, can we relieve trade of the burden of intermediate agencies, of the unnecessary expenses of cartage and boat-hire, and of such charges as may be attributable to the time and money spent by ships in navigating the Hooghly. The expense thrown, *per contra*, on trade by the termination of the voyage at Diamond Harbour is the extra cost of carriage of goods by rail to that point, and this the majority of the Committee think will be nothing in the case of goods booked through from up-country, and about one rupee a ton for goods booked to and from Calcutta.

7. In calculating the saving to ships and steamers by terminating the voyage at Diamond Harbour, the Committee reduced the amount to an extremely low figure. The calculations are given in paragraphs 33 and 34 of the report, and it will be instructive to compare them with those given by Mr. Morrison at page 102. It was at his instance that the Committee cut down their estimate and produced a result of saving of R520 only for a steamer and R2,479 for a sailing ship. But for the purposes of his own argument in support of the Mutlah Canal scheme he makes the saving to be—

	R
For a Coasting steamer	625
" Canal steamer	2,230
" Sailing ship	6,250

One omission in the Committee's estimate should be noticed. At the end of paragraph 41 it is stated that the dock charges of 14½ annas per register ton would cover all dock dues, wharfage, landing charges, &c., excluding only crane-hire and warehouse rent. But in paragraph 42, where the estimate is given of the cost of bringing a steamer to Calcutta, only "jetty charges," amounting to R385, are entered, and the "landing charges," &c., payable for the use of the jetties, and which are much the heaviest, are omitted, although in the case of the vessels using the Diamond Harbour dock the average charge of 14¼ annas per ton includes such charges. It should be observed that in the table given in paragraph 40 of the report, it is shown that the Port Commissioners actually realised an income of R7,14,189 for the use of the jetties from 193 vessels, or an average of R3,700 per vessel; whereas in the calculation given in paragraph 41, the Committee estimate that an income but slightly larger, R7,50,000, will be sufficient to make the docks a remunerative undertaking, and that it can be realised from 468 vessels—an average of R1,600 per vessel. There is here, therefore, a saving of R2,100, for which no allowance has been made in the Committee's estimate. The Committee's report just touches on this point in paragraph 46, but in the absence of figures giving the precise incidence of the charges in each case, we could not go into the matter more fully. I think there is no doubt, however, that the Committee's estimate of savings errs too much on the side of safety, and that Mr. Morrison is probably more nearly correct.

8. His estimate, again, at page x of the appendix gives almost fabulous figures for the savings in boat and cartage expenses. He gives these figures as the anticipated results of the Mutlah Canal scheme which he is advocating; but they are the supposed results simply of berthing ships in properly constructed and furnished docks, instead of in the open river as at present. They are therefore applicable with as much force to the Diamond Harbour scheme as to that of the Mutlah Canal. I should say that they apply with much greater force, for (1) the Diamond Harbour scheme will involve only half the capital expenditure of the other, and therefore the charges, so far as providing for interest is concerned, will be proportionately less; (2) it will reduce the distance between Calcutta and the sea to about half what it is now, and the saving due to this is an absolutely calculable quantity; whereas in the case of the Mutlah Canal, there is no reduction of distance, and although the navigation is assumed to be less dangerous, it will probably not be less expensive or dilatory than that of the Hooghly. There would be two sets of pilots—one for the river up to the entrance of the canal, and one for the canal itself, and the navigation of the latter will unavoidably be slow. The expense to sailing ships will certainly be much greater in the case of the canal than in that of Diamond Harbour, on account of the towage; they must be towed in the canal, but they would get up to Diamond Harbour without it. There would be delay in warping them through the locks, for they could not be towed in for want of space. Then, again, there are the important considerations given in paragraph 62 of the report. On the whole, it seems to me that all the advantages of economy, which Mr. Morrison claims for the docks of the Mutlah Canal, can be much more reasonably claimed for the Diamond Harbour docks; while as to the question of men's business being destroyed, or their interests assailed, the whole discussion seems to me to turn on the question of providing for an inevitable *increase* of business, not on its destruction. There may, indeed there must, be changes in the methods of carrying on business to provide for such increase, but I cannot see how any idea of destruction can rise. But supposing Mr. Morrison's figures to be accepted for the sake of argument, and that they are as applicable to Diamond Harbour as to the Mutlah Canal, we may form some estimate from them how greatly the savings resulting from the use of docks would exceed the extra carriage from Calcutta to Diamond Harbour The savings he estimates at R81,25,750, while the extra carriage on the total tonnage which entered the port would, at one rupee per ton, be R12,20,546.

9. But the main argument to my mind in favour of Diamond Harbour is that which I have given in paragraph 6 above. Leaving out of consideration ordinary Calcutta assorted cargoes, which it may probably always be preferable to bring up to Calcutta, it is clear from Mr. Leslie's note that there is reason to believe that a very large export trade in grain, coal, &c., might be created if only the appliances existed for delivering such cargoes cheaply into ships' holds. Such trade is strangled by the expenses of shipment as the business of the port is now conducted; and the prosperity of Bengal, the wealth of the agricultural population, and its consequent ability to cope with famines when they occur, depend enormously on the fostering of such trade.

10. The uncertainty of the permanence of the channels of the Hooghly below Diamond Harbour is a point which Mr. Morrison regards as almost fatal to the proposal to build docks there. But as he himself remarks, the Hooghly has been navigated for the last hundred years, and why not another hundred? Those who recommend the expansion of the existing accommodation at Calcutta, evidently are not deterred by any fear of the river closing. At any rate, we know all that is to be known of the Hooghly channels, but our experience of the Mutlah is almost nothing. There appears to me to be less wisdom in sinking three millions on a speculative transfer of the port to a new and almost unknown river than in spending a million and a

half in providing docks on a river which already forms the port of Calcutta, and of which we know the worst.

11. The opposition of the mercantile community throws a difficulty in the way of proceeding with the dock scheme. I think not only should we get a report and estimate from the Port Commissioners to set at rest the question of the possibility of extending the present port, but we should also appoint some one to investigate the scheme for the canal to the Mutlah, and frame as correct an estimate as possible of its cost. In the meantime I think the Committee's report should be made public.

Opinion of Mr. Robert Steel on the best means of providing sufficient accommodation for shipping.

I quite agree with the Committee that something must be done to accommodate the increased trade of the Port of Calcutta, which we must look for in the early future. The practical question at issue is whether this object can be best attained by the construction of docks at Diamond Harbour.

The alternative scheme, which was most prominently brought before the attention of the Committee, involved the construction of a dock in Calcutta itself, connected by a ship canal with the Mutlah, and also connected with the River Hooghly. I can offer no opinion as to the practicability of this scheme or its cost. Assuming, however, that the cost would be £3,000,000 as against £1,500,000 for the Diamond Harbour docks, I would consider the larger expenditure far preferable in every way. The canal from the Mutlah would evade the dangers of the Hooghly altogether; whereas the other scheme would not avoid the difficult navigation of the lower part of the Hooghly—the part where the channels are subject to the greatest disturbance, and where there seems to be the greatest fear of permanent deterioration.

At the same time, while expressing a decided preference for docks at Calcutta rather than at Diamond Harbour, I am of opinion that both schemes are premature, and that the means exist for providing for the accommodation of a trade, double in extent of that hitherto carried on, by improving the port of Calcutta itself. The first step in this direction should be the removal of the floating Hooghly Bridge to a point higher up the river. This bridge at present strangles the port, and renders a large part of the river frontage comparatively valueless on account of the delays, dangers, and expense of bringing vessels through the bridge. The next step should be the utilization of the river bank below Chandpaul Ghât. At present no use is made of this invaluable frontage, and Government has hitherto insisted that no scheme of port improvement shall be allowed to touch the frontage between Chandpaul Ghât and Prinsep's Ghât. It appears to me that the time has now come for the removal of this restriction. The space in question should be made use of for the construction of jetties and for the loading of cargo boats. If this involves the removal of the Eden Gardens, the throwing back of the strand bank road, and even the removal of the Fort itself, still it appears to me the proper solution of the difficulty. The Fort has already been moved from the site of the Custom House to its present position, because it was in the way; and sooner or later it must for the same reason be moved again. Such value as it has consists in its capacity to prove a rallying ground in case of tumult, and a barrack for soldiers, rather than in any necessity for commanding the river approaches. Some time or other it may be desirable to construct a wet dock either at Garden Reach or on the site of the present Fort.

I will not go over the detailed objections to the Diamond Harbour dock scheme which have been laid before the Committee. I will, however, state that, in my opinion, the scheme would not induce a large direct business between Diamond Harbour and up-country markets. Imports would continue to come to Calcutta and be distributed from thence. Exports would continue to come to Calcutta for assortment, packing, and sale. In my opinion, any gain from saving of risk and expense by terminating a voyage at Diamond Harbour will be more than counterbalanced by the expense of railway carriage between Calcutta and Diamond Harbour. In expressing this opinion I assume the correctness of the Committee's estimate of R1 per ton for railway carriage. At the same time I believe that this estimate is quite inadequate, and I cannot think that the Committee have taken into consideration the great outlay which would be necessary for trebling the line of rails and providing in a suitable situation in Calcutta extensive godowns for receiving and delivering goods. If full use is to be made of such a dock as that specified, the Calcutta goods station would require to have almost as much accommodation as the East Indian Railway station at Howrah, and would involve very great expenditure.

In my opinion, the proposed docks at Diamond Harbour would be unpopular on all hands both with the owners of ships and also with shippers and importers of goods. As a shipowner I would not accept a lower rate of freight for a voyage terminated at Diamond Harbour if an expense of R1 per ton on the cargo for railway carriage was thrown on the ship. As an importer of goods, or an exporter of produce, I would by no means employ a ship or steamer terminating her voyage at Diamond Harbour, unless at a lower rate of freight than that charged by ships coming to Calcutta. The detailed reasons for these objections on the part of merchants to the employment of Diamond Harbour have been put before the Committee by others and need not be repeated. It follows from what I have said that, in my opinion, docks in Diamond Harbour would not be made use of until trade was relunctantly driven there by an absolute deficiency of accommodation at Calcutta.

The Committee was appointed to consider the Diamond Harbour scheme only, and had no instructions to examine alternative schemes in detail. In consequence the Committee has been unable to cover the ground absolutely necessary to give practical value to its report. The *real* question at issue involves the detailed examination of all the practical alternatives—a task which, in the absence of instructions, the Committee could not attempt.

Minute by His Honor the Lieutenant-Governor of Bengal.

I think that all these papers should be published for general information before the Government can take any further steps in the matter.

The Committee, whose report is now under consideration, was appointed by the Lieutenant-Governor of Bengal, in December 1881, to examine the question of the construction of wet docks at Diamond Harbour, in view of the sanction which had then been received for a railway from Calcutta to that place. The railway referred to is now all but completed, and will be open to traffic in the course of a few weeks; and there can be little doubt that, if not at once, yet certainly with the completion of the railway bridge over the Hooghly (which will probably be finished in 1885), the advantages of a subsidiary port at Diamond Harbour would be very great to the mercantile and shipping community, if its establishment is within the limits of a practical and profitable undertaking. By the successful completion of such a project, the difficulties and dangers to which navigation of large ships above Diamond Harbour is exposed would be removed, the cost now incurred in bringing ships up the longer distance to Calcutta would be saved, the expenses involved in loading and unloading cargoes, in portage, and other similar charges would be diminished, and great convenience would probably result to the passenger traffic from and to Calcutta. It was not, however, with reference to these future possible advantages that the question of this Diamond Harbour dock scheme was mainly revived. The much more serious consideration has pressed itself upon our attention, that with the rapid development of railways converging on Calcutta, and the vast strides which the trade of the port has made within the last ten years, the existing accommodation for ships in the port of Calcutta is insufficient to meet the requirements of the increasing traffic. As to this fact, there appears from the 18th paragraph of the Committee's report to be no difference of opinion among the members of the Committee, who agree "that a large increase in the accommodation of the port of Calcutta will soon be an urgent necessity." The unanimity, however, begins and ends at this point; for on the further question as to the best means for meeting this difficulty, though a strong majority of the Committee are favourable to the Diamond Harbour project "as the most practicable scheme which has yet been proposed, and the one that offers the best prospect of financial success," it is found that the merchants of Calcutta, presumably those who are most nearly interested in its effectual solution, deprecate any measure which will tend to remove the shipping from the present limits of the port. This view, though not universally accepted by the mercantile community, is based on the opinion "that the transfer of a part of the business of the port to Diamond Harbour, or to any similar locality, would be attended with much inconvenience and expense." It would be necessary, it is urged, to keep up double establishments, and to rent a double set of warehouses: matters of importance will either have to be settled by subordinates, who will be unfit to deal with them, or will have to be delayed for the decision of a principal, who will be forty or fifty miles away. "The value of the property of the Port Commissioners, and of the owners of godowns in Calcutta, will be seriously depreciated. The example of Port Canning is sufficient to show the danger of attempting to divert trade into new channels."

The objection thus generally taken is further strengthened by the dissents which have been recorded by two eminent members of the Committee, representing the mercantile interests of Calcutta, who consider that there is room within the limits of the port for much further expansion of improvements, and agree with Mr. Duff Bruce, the Vice-Chairman of the Port Commissioners, that the present accommodation can be considerably increased. Mr. Keswick, in his note of dissent, adds that his " enquiries lead him to believe that it is possible for the Port Commissioners to acquire land on both sides of the river from Garden Reach downward, sufficient to double the accommodation of the port, and provide sufficient warehouse and jetty-room;" and Mr. G. H. Morrison, speaking with the authority of President of the Chamber of Commerce, records, among other objections to the proposal, the opinion that the docks at Diamond Harbour, if successful, would gravely prejudice Calcutta as a centre of trade, and probably ultimately destroy it as a port (page 98).

Now, in considering the measures which have been adopted during the last twelve years to extend the facilities within the port, it is desirable to notice the great improvements which have been made under the Port Trust. Twelve years ago (I am quoting from the report of the Committee on the Diamond Harbour Dock project) " there were no jetties, wharves, warehouses, or appliances available generally for loading or unloading vessels in the Port of Calcutta. Vessels were moored in the river and cargoes were discharged and taken in by means of cargo-boats. The Port Trust was established in 1870, and since then great facilities have been provided by the construction of jetties supplied with suitable goods-sheds, hydraulic and steam-cranes, and a line of tramway in rear of the jetties in connection with the Eastern Bengal Railway." During the period in question the number of jetties has been doubled. There are now eight of them, and the extent and growth of their advantages may be gathered from the fact that, while the number of vessels accommodated by the jetties was in 1869-70 only 75, in 1880-81 there were 193. Again, whereas in 1871-72 (the earliest date for which figures are available) the total jetty receipts for imports and exports came to R3,63,145, in 1880-81 they amounted to R7,14,189. The report goes on to say that " these jetties and their appliances for loading and unloading are all of the latest approved types of construction, and admirable in all respects. If there were room in the port for extending them from time to time to meet the growing trade, it seems probable that such a course would be adopted in preference to taking up new ground for docks at a distance from Calcutta, and that merchants would be content to trust, at all events till the growing size of vessels exceeded the draft available in the river, to the acknowledged skill of the Pilot Service to overcome the dangers of the navigation of the Hooghly. But the jetty accommodation is not really sufficient even for the existing trade of the port, and the evidence we have collected shows that, *although room might be found for some extension, yet it is very doubtful whether the space available in port could be made adequate at any reasonable cost to meet the increased trade that will be brought to Calcutta by the opening of the railway bridge over the Hooghly, and the extension of railways in Bengal.*"

The part which I have italicised in the above quotation raises an issue as to facts regarding which the dissenting members of the Committee at all events are opposed to the majority of the Committee; and it is due, I think, to the influential body who take this objection, and who after all are the most interested in the settlement of the question, that the matter as to the further capabilities of the extension of the port should receive a fuller and closer investigation than has yet been attempted. It is quite true, as Colonel Trevor points out, that by merely expanding existing appliances we do not touch the great drawbacks of the port and the main causes of its expensiveness, which lie in the 120 miles of extremely difficult river navigation, involving heavy charges in pilotage and detention. The Diamond Harbour scheme, if established, would at once diminish these and other evils in the present system. On the other hand, the proposals of the Committee subvert all the present business arrangements of the port, and I am quite certain that the Government could not commit itself to any project involving an outlay of a million and a half of money without a detailed discussion of the alternative suggested of extending the accommodation in the present limits of the port. It is scarcely necessary for me, upon this view of the case, to state at length my own views. But I confess that I entertain very strong doubts whether any possible extra facilities within port limits will afford more than a very temporary relief. The future developments of trade which the continual progress of railways encourages are incalculable; and when the bridge over the Hooghly is finished, and direct communications with Calcutta have been established from the producing districts of the North-Western Provinces, and the tracts of country served by the Northern Bengal, the Central Bengal, and the contemplated line from Seetarampore to the Central Provinces, with their connected branches, the space at present at the disposal of the Port Commissioners seems to me to be utterly inadequate. I leave out of question the lines which are under survey and construction in the Dacca and Mymensingh districts, and the lines protected under the same general system towards Tipperah, Cachar, and Chittagong, because all the produce and trade of those regions seems, upon the most cursory view of the map, to be likely to seek its most natural outlet from the port of Chittagong. But even with such relief as this may give, I doubt whether any economy of space, or any extension of jetties and appliances within present port limits, will meet its requirements a few years hence. As the issue, however, has been directly raised by the merchants of Calcutta, it is right that it should be settled before any action is taken upon the Diamond Harbour proposals.

I propose, therefore, to publish the papers with this minute and the note recorded by Colonel S. T. Trevor on the 4th August last. I would ask the Port Commissioners, in communication with the Chamber of Commerce, to institute an enquiry as to the measures possible for extending the present accommodation of the port, and the cost at which such changes could be effected. I limit myself to this point, because the Mutlah Canal scheme, which has strong advocates in some members of the mercantile community, has more than once been under discussion, and no serious effort has ever been made to raise the capital required for its prosecution. In forwarding, however, the papers to the Government of India, and explaining the action we have taken, it may be stated that, if they deem it advisable, a professional survey of this work would be undertaken. Our object is to discover a remedy "for the present congestion;" and if every scheme which is started has to be investigated in all its details, we shall have to postpone practical action to an indefinite period. If the extension of the existing accommodation of the port fails us, I see no better hope for relief than in the establishment of a subsidiary port at Diamond Harbour in connection with the railway to that place which is about to be opened.

17th February 1883.

From Colonel W. S. Trevor, R.E., Secretary to the Government of India, to the Secretary to the Government of Bengal, Public Works Department,—No. 116M., dated Fort William, the 14th March 1883.

I am desired to acknowledge the receipt of your letter No. 615 M.P.I., of the 23rd ultimo, with enclosures, on the subject of constructing docks at Diamond Harbour, and to state that the Government of India entirely concur with His Honor the Lieutenant-Governor as to the necessity for further enquiry regarding the extensions of accommodation possible at Calcutta itself, before embarking on any scheme for providing docks at a distance.

2. Without attempting to prejudge the question at its present stage, His Excellency the Governor General in Council cannot but feel that there is some force in the objection of the mercantile community to being compelled to carry on one portion of their business at a place some forty miles distant from their head-quarters, and in the argument that it is improvident to commit for ever the trade of the large portion of India commanded by Calcutta to the risks and inconveniences of one portion of the Hooghly River in order to escape those of the other. If it were found possible to construct docks in the vicinity of Calcutta itself, this dilemma would be avoided, and while, indeed, the risks and delays of the Hooghly would remain as at present, the possibility would remain open of avoiding them, at any future time when the trade could bear the charge, by means of a canal connecting the docks with the Mutlah River.

3. I am therefore desired to suggest that the enquiry by the Port Commissioners should embrace the feasibility and cost of a wet dock of reasonable size, but capable of enlargement hereafter, and the expediency of the Commissioners themselves carrying out the project by means of capital to be raised by them for the purpose. Due consideration will, no doubt, be bestowed by them upon the various projects which are enumerated in the 9th and 10th paragraphs of the Diamond Harbour Committee's Report, and especially on those for docks at Akra, which have lately been reproduced, in a somewhat different form, by the Port Officer of Calcutta, Lieutenant Stiffe.

4. In connection with this subject, I am to state that His Excellency the Governor General in Council approves of the recommendation of the Government of Bengal, in paragraph 13 of Mr. Levinge's letter No. 969R. of the 23rd ultimo, that for the present at least the question of the central goods station in Calcutta should remain in abeyance. In dealing with goods traffic, it appears essential that all unnecessary handling should be avoided, that all carting and boating intermediate between railway wagons and shipping should be eliminated as far as possible. If docks at Calcutta should be found feasible, the most convenient situation for a depôt for all goods, except those intended for local consumption, will obviously be one in immediate connection with the docks.

5. In conclusion, I am to suggest that, in view of the great importance of making early provision for the rapidly growing trade, the Commissioners may be requested to submit their report at the earliest practicable date.

Report of the Committee appointed by the Port Commissioners to consider, in communication with the Chamber of Commerce, the measures which it is possible to take for the extension of the present accommodation of the Port, and the cost at which any changes which may be recommended can be carried out.

Reasons for appointing Committee.

The Committee was appointed, in pursuance of an order recorded by His Honor the Lieutenant-Governor in a minute, dated 17th February 1883, upon the report of the Committee appointed in December 1881 to consider the question of constructing docks at Diamond Harbour. That Committee, while unanimous in reporting that the existing accommodation for ships in the port of Calcutta is insufficient to meet the requirements of the traffic, and that a large addition to the accommodation of the port will soon be an urgent necessity, differed as to the project of docks at Diamond Harbour being the best means of meeting the increasing demands of the trade. A strong majority, composed mostly of Government officers, were in favour of the scheme, which was unanimously opposed by the mercantile members of the Committee. In the face of this opposition, and having regard to the opinion expressed by the dissenting members of the Committee as to the possibility of providing, in Calcutta itself, the requisite accommodation for the increasing trade of the port, His Honor the Lieutenant-Governor recorded, in the minute above alluded to, his opinion that " it was due to the influential body of objectors, who are after all the most interested in the settlement of the question, that the matter as to the further capabilities of the extension of the port should receive a fuller and closer investigation than has yet been attempted."

Scope of Committee's enquiry defined.

2. In pursuance of this expressed opinion of His Honor the Lieutenant-Governor, orders were communicated to the Port Commissioners in Public Works Department letter No. 616 M.P.I., dated 23rd February 1883, calling upon " the Commissioners, in communication with the Chamber of Commerce, to institute an enquiry and submit a report as to the measures which it is possible to take for the extension of the present accommodation of the port, and the cost at which any changes which may be recommended can be carried out." These instructions were further supplemented by an order, No. 896 M.P.I., dated 20th March 1883, Public Works Department, Bengal, under which a copy of Government of India letter No. 116M., dated 14th March 1883, was forwarded for the information and guidance of the Port Commissioners in the preparation of the report already asked for. In this letter, No. 116, of the Government of India, it was suggested to the Government of Bengal that the scope of " the enquiry by the Port Commissioners should embrace the feasibility and cost of a wet dock of reasonable size, but capable of enlargement hereafter, and the expediency of the Commissioners themselves carrying out the project by means of capital to be raised by them for the purpose; due consideration being given to the various projects" previously brought forward for providing docking accommodation for the shipping of the port.

Appointment of Committee.

3. On receipt of these orders of Government, the Commissioners at the 384th meeting appointed the following members of their Corporation to serve on the Committee :—

H. A. Cockerell, Esq., C.S., C.S.I., Officiating Chairman.
D. Scott, Esq., C.E., the Offg. Vice-Chairman; subsequently relieved by W. Duff Bruce, Esq., C.E., Vice-Chairman.
Franklin Prestage, Esq., C.E., Agent, Eastern Bengal Railway.
W. P. Alexander, Esq., of Messrs. Mackinnon, Mackenzie & Co.
J. J. J. Keswick, Esq., of Messrs. Jardine, Skinner & Co.

Advantage was taken of the first vacancy which occurred in the Commission to bring Mr. Bradford Leslie upon the board, and he was at once appointed an additional member of the Committee. Shortly afterwards Mr. Leslie went on leave, and on his return to Calcutta withdrew from the Committee in consequence of the other members determining to press upon Government the expediency of constructing the new railway bridge at Cossipore instead of Hooghly. The Chamber of Commerce nominated the following members to serve on the Committee :—

The Hon'ble R. Miller, President of the Chamber, of the firm of Messrs. Hoare, Miller & Co.
H. B. H. Turner, Esq., of the firm of Messrs. Turner, Morrison & Co.
James Stevenson, Esq., of Messrs. Graham & Co.

Subsequently on Mr. Miller leaving for England the Chamber nominated—

Lorraine King, Esq., of the firm of Messrs. Vale, King & Co., to serve in place of Mr. Miller.

Meetings held.

4. The Committee, as above constituted, met on the following dates:—

April	7th,	1883.
„	14th,	„
„	28th,	„
May	5th,	„
„	9th,	„
June	6th,	„
„	7th,	„
„	11th,	„
„	15th,	„
„	28th,	„
August	9th,	„
„	10th,	„
August	13th,	1883.
„	14th,	„
„	15th,	„
„	16th,	„
„	20th,	„
„	21st,	„
„	23rd,	„
„	27th,	„
„	28th,	„
„	29th,	„
September	3rd	„

Oral evidence not considered necessary.

5. Looking to the very complete evidence taken by the Diamond Harbour Committee, as recorded in the appendices to their report, and to the practical knowledge of the requirements of the commerce of the port possessed by several members of the Committee, it was not considered necessary to examine witnesses.

Distinctive features of the trade of the port.

6. Before proceeding to consider in detail the several proposals which they have had before them, and the particular proposals which they have agreed to accept and recommend for adoption, the Committee desire to draw attention to some of the special characteristics of the trade of the port of Calcutta, and to the following facts in connection with the nature and extent of its shipping business. The annual administration reports of the Port Commissioners record the number and tonnage of the vessels, distinguishing steamers from sailing vessels, arriving and leaving port, the vessels being classed both according to draft and tonnage; but for the purposes of this report it has been found necessary to analyse the returns available, so as to arrive at the trade in which these vessels are employed, and the quantity of imports into, and exports from, Calcutta. It has also been considered advisable to attempt some further classification in regard to imports and exports, with a view to ascertain the accommodation required, and the best facilities which could be given for discharging and loading the vessels. The total number of ships which entered the port during the year 1882-83 was 1,151, and the total tonnage was 1,510,344 tons net, and 1,982,187 tons gross register. The jetties accommodated all the general import cargo vessels, other than those from China and coasting ports; and the number of vessels berthed at the jetties during the year was 199. Taking these figures and the further particulars furnished by the list of entries at the Custom House, the following classification of the 1,151 vessels which arrived during the year is here given, as showing in a general way how the import trade of the port is distributed among the vessels engaged in it:—

	Number.	Tonnage net.
Vessels bringing general cargo from ports of the United Kingdom and Europe	199	375,947
Vessels from China, the Straits, and Coast Ports	332	356,155
Vessels from the United Kingdom, bringing railway material and iron	33	47,886
Vessels bringing horses, and in some cases a few articles of import	11	14,765
Ditto petroleum	27	37,179
Ditto coals	40	57,440
Ditto salt	174	234,171
Ditto ballast	335	386,841
TOTAL	1,151	1,510,344

Increase in tonnage.

7. The figures given in paragraph 43 of the Commmissioners' Report for 1882-83 show that there has been a progressive increase during the past four years in the tonnage of the port, the figures being as follows:—

Year.	Number.	Gross tonnage.	Net tonnage.
1878-79	967	1,430,789	1,115,392
1879-80	896	1,415,979	1,103,013
1880-81	984	1,579,868	1,220,546
1881-82	1,074	1,808,905	1,377,399
1882-83	1,151	1,982,187	1,510,344

Abstract of imports.

8. The following statements are abstracts of the imports and exports of the year 1882-83, as far as they can be collected from the Custom House and other available returns. The information regarding exports is for all the large staples, as full and accurate as it can possibly be; but, in the matter of imports, the information is defective, inasmuch as only the values and not the quantities of a number of the items are recorded in the Custom House returns. The Jetty returns give the quantities of all general cargo, and these have been taken to supplement the Custom House import lists.

Statement of Principal Articles imported into Calcutta during 1882-83.

Articles.	Tons.
Salt	326,555
Piece-goods	81,055
Iron, bar, sheet, rod, &c.	76,522
„ rails and sleepers	56,095
Coals	75,513
Oils	58,243
Machinery	29,469
Timber	42,748
Seeds	29,433
Gram and pulse	26.553
Cocoanuts, nuts, and vegetables	18,208
Beer, wine, &c.	15,554
Building materials	11,650
Copper	11.502
Stones and marble	9,593
Cotton, raw	8,791
„ twist	5,846
Spices	5,744
Provisions	5,742
Coir	4,579
Miscellaneous goods recorded by weight	57,553
„ „ recorded by measurement	83.565
TOTAL	1,040,513

Abstract of exports.

9. The following is an abstract of the principal exports for the year 1882-83, and, as far as the return will admit, the corresponding figures for the four previous years are shown in comparison with the returns of 1882-83:—

Comparative Statement showing Principal Articles of Export from Calcutta during the past five years.

	ARTICLES.	1882-83.	1881-82.	1880-81.	1879-80.	1878-79.
		Tons.	Tons.	Tons.	Tons.	Tons.
1	Grain, rice	500,906	472,708	424,126	254,903	387,001
2	Jute, raw	462,068	347,683	271,382	315,777	287,727
3	Grain, wheat	222,188	333,810	199,904	84,435	50,991
4	Seeds, oil	281,975	233,964	301,389	204,877	255.368
5	Gunny bags	139,122	102,292	102,130	100,766	85,009
6	Cotton, raw	4,215	3,507	3,070	2,616	2.588
7	Hides and skins	26,449	24,764	27,498	37,271	28,193
8	Cotton, raw	25,740	35,147	43,869	40,705	17.201
9	Tea	25,573	21,498	20,660	16,985	15,367
10	Saltpetre	20,034	17,678	17,567	25,408	19,107
11	Grain, other sorts than wheat	31,677	30,736	29,595	37,033	51,099
12	Sugar	13,382	8,011	3,593	9,261	8,122
13	Oil, castor	9,277	10,685	11,188	10,150	8,705
14	Opium	4,104	4,143	4,145	4,349	4,026
15	Betelnuts	11,529	9,716	7,797	9,367	8,650
16	Lac	6,662	5,587	4,028	2,798	4,076
17	Tobacco (leaf)	8.642	7,114	9,426	6.771	10.321
18	Dye, indigo	4,993	4,596	4,410	2,398	3,747
	TOTAL	1,798,536	1,673,639	1,485,777	1,165,870	1,247,298

The increase in the export trade is indicated by the foregoing figures, and although the quantity of wheat exported during 1882-83 has fallen 33⅓ per cent. below the shipments of the previous year, this trade has, during the past four years, developed considerably. The exports of raw jute show a marked increase, as do also gunny bags; the latter during 1882-83 being 35·75 per cent. over the quantity for either of the two preceding years.

Ports for which exports are shipped.

10. The ports to which this produce was shipped during 1882-83 are shown in the following statement:—

ARTICLES.	United Kingdom.	Continental Europe.	Africa.	United States.	West Indies.	Australia.	Ceylon, Burmah, Coast Ports, and China.	TOTAL.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Rice	70,326	...	68,281	...	33,733	3,451	325,115	500,906
Jute, raw	336,296	22,017	...	100,136	...	1,150	2,469	462,068
Wheat	174,944	37,751	9,316	...	...	...	177	222,188
Seeds, oil	231,754	29,849	...	19,994	...	378	...	281,975
Gunny bags	1,096	...	2,710	14,326	1,241	29,157	90,592	139,122
Hides and skins	14,801	5,536	...	5,746	...	...	366	26,449
Cotton, raw	15,266	2,715	...	...	...	...	7,759	25,740
Cotton twist	...	...	...	...	...	...	4,215	4,215
Tea	23,978	...	...	279	...	1,211	105	25,573
Saltpetre	6,598	2,876	1,085	5,193	...	...	4,282	20,034
Grain, other sorts	...	...	2,712	...	18,228	1,294	9,443	31,677
Sugar	8,383	65	...	...	...	...	4,934	13,382
Oil, castor	5,529	297	...	...	...	2,105	1,346	9,277
Opium	...	...	...	...	...	...	4,104	4,104
Betelnut	...	...	...	...	...	...	11,529	11,529
Lac	4,898	...	...	1,726	...	38	...	6,662
Tobacco	240	465	199	...	...	...	7,738	8,642
Dye, indigo	2,346	1,191	...	1,242	...	...	214	4,993
TOTAL	896,455	102,762	84,303	148,642	53,202	38,784	474,388	1,798,536

Growth of traffic on East Indian Railway.

11. The great increase in the downward traffic on the East Indian Railway is shown in the following statement, copied from paragraph 4 of a memorandum furnished by Mr. Bradford Leslie to the Diamond Harbour Dock Committee, and to these figures have now been added the actuals for the year ending 31st March 1883:—

Statement of East Indian Railway Goods Traffic downwards from 1871 to 1880.

	RECEIVED AT HOWRAH.	
	Coals.	Other goods.
	Tons.	Tons.
1871	185,969	192,533
1872	231,727	181,161
1873	292,873	219,733
1874	311,924	215,976
1875	293,796	295,818
	1,316,289	1,105,221
Average per year	263,257	221,044
1876	274,387	531,189
1877	308,484	738,273
1878	398,587	533,270
1879	389,450	543,501
1880	387,836	627,515
	1,758,744	2,973,748
Average per year	351,748	594,749
For year ending 31st March 1883	502,763	815,047

Summary showing the Monthly Arrivals of Goods at Howrah.

	Rice.	Wheat.	Pulse.	Seeds.	Hides.	Cotton.	Saltpetre.	Total.
1882.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
April	4,345	11,076	4,168	22,388	1,396	2,778	2,663	
May	3,724	30,741	7,942	37,787	1,416	1,605	2,358	
June	3,352	33,110	6,886	37,429	1,419	858	2,187	
July	1,894	25,376	5,581	26,546	913	586	1,298	
August	895	24,807	3,850	45,367	1,149	505	1,899	
September	1,261	9,194	2,603	20,979	1,240	206	1,319	
October	1,012	13,108	3,844	21,177	1,287	623	1,431	
November	5,315	27,720	8,533	23,949	1,920	3,002	2,745	
December	9,688	21,668	6,294	18,224	2,889	6,274	2,172	
1883.								
January	3,490	6,998	5,090	11,793	2,164	3,856	2,109	
February	2,155	11,846	3,772	13,339	2,628	4,839	2,117	
March	3,593	14,432	3,992	15,715	2,869	3,255	2,264	
TOTAL	40,724	230,076	62,555	294,693	21,290	28,387	24,562	

Traffic into Calcutta for shipment.

12. During the year 1882-83 the total tonnage of the goods received by rail at Howrah amounted to 1,317,810 tons, and of this quantity 746,408 tons were of the class of goods exported by sea from Calcutta, as shown in the following statement. The quantity of goods received at the Calcutta terminal stations of the Eastern Bengal Railway during the same period amounted to about 400,000 tons, of which 341,693 tons were of the class of goods exported. An attempt has been made to get the correct quantities of the river-borne trade into Calcutta, but although the boat returns are correct, as far as the Calcutta canals and Nuddea rivers are concerned, they do not include a large number of boats which pass no toll stations, and are not therefore included in the canal returns.

Statement showing the Amount brought down by the two Railways, by Boats and Inland Vessels.

ARTICLES.	Quantity shipped.	Quantity brought by East Indian Railway.	Quantity brought by Eastern Bengal Railway.	Quantity brought through canals and Nuddea rivers by boats.	Quantity brought by river steamers and flats.
	Tons.	Tons.	Tons.	Tons.	Tons.
Rice	500,906	40,724	30,877	379,718	...
Raw jute	462,068	106	252,578	228,521	77,188
Oil-seeds	281,975	294,693	6,341	48,011	2,018
Grain, wheat	222,188	230,076	...	20,133	...
„ other sorts	31,677	6,868	Included in rice.	79,526	...
Pulse	Included in grain.	62,555	Ditto.	...	...
Gunny bags	139,122	431	15,611	...	...
Cotton twist	4,215	...	...	...	...
„ raw	25,740	28,387	2,341	...	...
Hides and skins	26,449	21,290	6,226	...	...
Tea	25,573	231	7,680	...	17,618
Saltpetre	20,034	24,562	...	...	...
Sugar	13,382	6,274	7,018	...	...
Castor-oil	9,277	761	...	...	...
Opium	4,104	7,551	...	...	...
Betelnut	11,529	...	...	12,955	1,760
Lac	6,662	8,291	137	...	...
Tobacco	8,642	559	10,199	7,460	...
Dye, indigo	4,993	5,776	2,685	...	...
Firewood	...	...	...	168,560	...
Lime	...	...	...	43,444	...
Jaggery	...	...	...	13.938	...
Vegetables	...	...	...	10,619	...
Miscellaneous	...	7,293	...	...	2,301
TOTAL	1,798,536	746,428	341,693	1,012,885	110,515

Character of export cargo, and necessity for examination of produce in Calcutta.

13. In deciding on the facilities which should be recommended for the convenience of the trade of the port, the Committee have had to consider the present practice in dealing with the chief export staples. One of the advantages claimed for the Diamond Harbour Dock scheme, as stated in paragraph 49 of the Committee's report, was that goods from up-country could be taken alongside vessels and placed direct into the ships' hold from the railway wagon. The mercantile members of the Committee, in recording their dissent from the report, took the opportunity of pointing out that the peculiar circumstances of the Indian trade practically prohibited such direct shipment. In the case of grain, wheat, seeds, and most country produce, the Calcutta merchant and exporter has to exercise a most vigilant supervision over the cargo purchased up-country and sent down to him. In America and elsewhere special agencies are employed in the interior of the country for dealing with the producer and seller of the cargo, and after satisfying themselves as to the class and condition of the goods, a certificated receipt is given to the seller for an exact weight of a particular class. This receipt, or warrant as it really is, becomes an order for delivery at Chicago or New York, or by transmission to a buyer in Europe, who receives ultimtely grain of the weight and quality mentioned in the certificate. No such facilities are to be found at this port, and the Calcutta merchant has no security as to what his purchases may turn out to be on arrival at Howrah. The contents of the bags may, owing either to carelessness or fraud, be mixed with dirt; where not so adulterated, they may be of mixed quality, uneven in weight, and partly damaged in transit It is therefore an absolute necessity to the Calcutta shipper to examine, weigh, and, where necessary, sort and re-bag his cargo before sending it on board. The Committee fear that in a country like India, where fraudulent packing is so common, the introduction of the American system is hardly practicable. For the present, most of the cargo indicated must be examined and dealt with before shipment, and for this reason the accommodation to be provided should be as close to Calcutta as possible, and sufficiently large to meet the requirements of the trade, and give every facility for the examination, sampling, and sorting of large grain and seed cargoes.

Calcutta jetty work practically confined to import work.

14. Hitherto the operations of the Port Commissioners have been restricted almost entirely to import cargo brought from ports of the United Kingdom and the European continent. Occasionally a China steamer has discharged two or three hundred tons of cargo at the jetties, but this has been the exception, and only a small portion of the jetty revenue (about one-eighth) has been derived from charges on goods shipped over the jetties. Vessels bringing general cargo from the United Kingdom and European ports discharge their cargoes, as a rule, entirely at the jetties. For the convenience of this trade, the Commissioners are constructing large warehouses inside the jetty enclosure, by the use of which the charge for removing goods from the jetties to warehouses in town will be avoided. From the general cargo ships, railway material intended to be despatched up-country from Howrah is delivered over-side into boats, and the same practice formerly obtained in regard to railway material intended for despatch by Eastern Bengal Railway, such material being landed from boats at the Chitpore terminus of the line. The connection of the Eastern Bengal Railway with the jetties by the Commissioners' Tramway did away with this over-side delivery of all goods despatched by the Eastern Bengal line, and when the East Indian Railway crosses the Hooghly, delivery of goods intended for despatch by that line will no longer require the intervention of cargo boats. The present jetties have been so continuously occupied by the discharge of vessels bringing general imports that neither salt-ships nor the bulk of the vessels employed in the export trade of the port have been able to obtain jetty accommodation. All these vessels have at present to lie out in the stream, and to discharge and load into and from cargo boats or lighters, and consignees and shippers of goods have to send the cargo boats and make all the necessary arrangements for putting export cargo into, and taking import cargo out of, the boats. It is for these vessels—673 in number during 1882-83—that the Committee have considered the necessity for accommodation.

Question of extending jetty accommodation.

15. One of the points to which the attention of the Committee was first directed, was the feasibility of providing this accommodation by erecting additional jetties within the limits of the port, and at an early meeting of the Committee, plans were submitted showing sites available for twenty-one additional jetties on the Calcutta side of the river in positions where they could be erected without causing inconvenience. On the Howrah side of the river another twenty jetties could be erected between the Botanical Gardens and the lower boundary of the port, and connected by a direct line with the East Indian Railway. The space between Chandpaul Ghât and Prinsep's Ghât, and the frontage of the King of Oude's property at Garden Reach, have been omitted from the frontages available for the construction of jetties, as

the Committee presume that there would be strong objections to devoting those portions of the river bank to commercial purposes. Calculating the cost of these jetties on the data available, and assuming that the sections throughout would be the same as No. 8 jetty, the cost of constructing 41 jetties, averaging 450 feet in length, would be R2,05,00,000. Allowing 14 days to each vessel, these additional jetties would accommodate 1,066 vessels annually. In order to give to vessels using the jetties lower down the port equal advantages with those afforded to vessels using the town jetties, it would be necessary to connect them with the Commissioners' Tramway line, which should be continued along the river bank from Chandpaul Ghât to Garden Reach. It may here be explained that the jetties above referred to are not jetties in the ordinary sense of the word, but form a continuous wharf. Detached tee-headed jetties were at first constructed in Calcutta, but were found to be of very little use for discharging a general import cargo. Heavy bales, casks, and cases, machinery, iron, &c., all had to be taken up from the holds, and passed along the ship's deck to a point at which the jetty crane could lift them on shore. One of the earliest works undertaken by the Port Trust, on its incorporation in 1870, was first to extend and then to connect the short jetties so as to make them into a continuous wharf. Such a wharf was absolutely necessary for the import trade, but it costs almost as much to provide accommodation in this shape as it would take to give the same extent of accommodation in docks, while vessels lying at jetties have neither the security nor the conveniences that could be afforded in a suitably arranged wet dock. It was therefore considered that if any extension of the existing jetty accommodation should be provided for the import trade, it should be limited to two jetties to the south of No. 8 jetty, at a cost of 11½ lakhs. The Committee would, however, strongly deprecate any further expenditure in providing jetty accommodation, but should there unfortunately be any delay in giving effect to the proposals now submitted for the construction of wet docks, it will be absolutely necessary to commence at once the construction of two additional jetties to the south of No. 8 jetty. It would take at least two years to complete these two jetties; and it seems very doubtful under such circumstances, and with special reference to the fact that the space available for shed accommodation and working tramway lines would be very contracted, whether the proposed expenditure of 11½ lakhs should be incurred.

Proposed transfer of Kidderpore Dockyard in lieu of Sulkea Docks.

16. It will be seen from the recommendations made later on in this report, in regard to the construction of wet docks, that the Committee have fixed upon a site for the docks at Kidderpore with two entrances to the docks through the Government Dockyard premises. This position is the best and most suitable within the port for a dock entrance, and the Committee are of opinion that, so far as the acquisition of the land necessary for entrances at this site is concerned, Government will be able to assist in carrying out the scheme without causing any inconvenience to Government work, and at the same time materially adding to the conveniences for the traffic of the port. Now that nearly the whole of the work which used formerly to be done in the Government Dockyard has passed into the hands of the Commissioners, there seems to be very little work left to be done in the dockyard premises. The pilot brigs and a few Government steamers would still require the use of the docks, but for these the Commissioners might undertake to find accommodation when needed, while the great bulk of the work in connection with the Government steamers might be transferred to the new engineering shops at Bishop's College. In the interests of all concerned, it would appear that these changes would be better than the arrangements now in force. At the Government Dockyard there is every convenience in the shape of buildings, docks, and machinery for carrying on the work of the Port Commissioners, and most of this work is work which, before 1870, was entirely done in the Government Dockyard. The effect of the transfer to the Commissioners of the management and control of the port and the river survey, buoying, and light-vessels, has been to remove from the dockyard the greater portion of the work which of late years has been done there. For the repairs of the pilot brigs and a few steamers such an extensive establishment cannot now be wanted; and while at the dockyard recently acquired by the Commissioners they will have to provide new buildings and accommodation for the business transferred from Government, there is every probability of the buildings in the Government Dockyard being very little required. The present dry docks in the Government yard are small and not suited in any way to meet the requirements of the present day. The Committee have been informed that a proposal is now before Government for the construction of a large dry dock upon the premises, cabable of taking in any of Her Majesty's vessels employed on the East Indian station. But it will be seen that, in the plans submitted with this report, the Committee have provided for the construction of a large graving dock in connection with the wet docks, and immediately adjoining the present workshops. This graving dock and the whole of the facilities to be provided by the wet docks would, in cases of emergency, be at the disposal of Government; so

that, in the event of Government having at any time to fit out an expedition for service, there would be far fore complete appliances at their disposal than are now available. Extensive workshops have been erected at the new Engineering College at Seebpore, and that institution is becoming more important every day. All the repairs of the dredgers, steamers, boats, machinery, &c., of the Public Works Department, which used formerly to be done at the Government Dockyard, are now done in the Seebpore shops; and the more work that can be made over to them, the better it will be for the College, and the greater the opportunities which will be given to the students studying there for acquiring experience in different branches of engineering work. Under these circumstances, the transfer of the dockyard premises at Kidderpore to the Port Trust, to be utilised for the purpose of providing suitable wet-dock accommodation in the port, would not, the Committee believe, cause inconvenience to Government; but, in the event of Government requiring the maintenance of a dockyard of its own, their requirements might be met by the Port Commissioners giving over, in exchange for the Kidderpore premises, the dockyard at Howrah, recently acquired by them. The large dock on the Commissioners' premises is more suitable for vessels of the Indian Marine than the small dry docks at Kidderpore, and the position is quite as convenient for Government work as the site of the present Government yard. Should Government, however, not desire to keep up a dockyard establishment of its own, the docking premises recently acquired by the Commissioners might be made over to the Railway Company, and thus enable them at once to give great additional facilities for the loading of cargo boats, and considerable relief to those engaged in the export trade of the port. The very considerable increase in exports, brought down from up-country by the East Indian Railway, has rendered necessary a great extension in the facilities for shipment into boats from the railway frontage. The Committee are cognizant of all that has been done, and what is still in progress at the terminal goods station of the East Indian Railway Company at Howrah, in regard to means for giving immediate relief to the export trade of the port. But they are, nevertheless, of opinion that increased accommodation will be required next year, and the dock premises recently acquired by the Port Commissioners, if made over to the Railway Company, might be utilised in whatever way the Company may consider most desirable. The East Indian Railway Company, looking to the general interests of the port, would, no doubt, consent to allow the dry dock to remain available for vessels requiring docking, until such time as other suitable docks have been constructed in the port.

Extension of East Indian Railway line along frontage to Shalimar.

17. In addition to this extension of railway accommodation to the northward, there is another means of relief for the traffic to the south of the existing railway premises, but it will take some time yet to get the works sufficiently advanced to enable cargo boats to use them. From Shalimar Point on the south, up to a point within a thousand feet of the Railway Company's premises, the Commissioners are in possession of the river frontage, and are constructing an embankment, road, and wharf along the whole length. It would add greatly to the convenience of the public if the land belonging to Messrs. Burn and Co. and Messrs. King & Co., necessary to continue this public river-side road and wharf right up to the East Indian Railway Company's frontage, could be acquired. But the Committee fear that the cost of taking up these frontages would be out of all proportion to the advantage gained; and if arrangements can be made for the acquisition of sufficient land to construct a railway, and so enable the Commissioners to place the new wharf at Howrah in direct communication with the East Indian Railway, there will be no necessity to acquire these frontages. An estimate of the cost of acquiring the necessary land, and extending the East Indian Railway lines as far as Shalimar Point, and there making up an area of about 50 bighas of land on which to construct export sheds, will be immediately submitted to the Port Commissioners; and the Committee recommend that the estimate be sanctioned, and this work proceeded with at once. With the wharves so extended, suitable warehouse accommodation provided, and the railway sidings carried along the wharf, delivery into boats would no longer be restricted to the Railway Company's premises; the whole wharf would in fact become an extended goods station, from which goods could be delivered direct into warehouses or cargo boats in the same way as delivery is given from the Commissioners' Tramway along the wharves on the Calcutta side of the river. Some objections might possibly be raised at first by the traffic officers of the East Indian Railway Company to this scattering of the points of delivery, but in practice there would be no more difficulty experienced at Howrah than has been met with on the Calcutta side of the river.

Proposals for wet docks.

18. Having discussed the question of extending the accommodation of the port by constructing new jetties, and also the arrangements by which early, if not immediate, relief can be given to the present

restricted accommodation for carrying on a large portion of the export trade, the Committee proceeded to consider how the increasing demands of the general trade of the port could best be permanently provided for. After full and careful consideration it has been decided to recommend that the extension of port accommodation should be given in the form of wet docks in preference to constructing additional jetties. Facilities to meet the special requirements of the export trade at Howrah during the time docks are under construction will be provided by the additional frontage now being reclaimed by the East Indian Railway Company, and also by the new wharf the Port Commissioners are constructing on the Howrah foreshore road. This wharf when connected with the East Indian Railway line, as explained in the foregoing paragraph, will afford great additional facilities to the export trade. The Committee being unanimously of opinion that the general trade of the port can best be accommodated in docks, both on account of the greater facilities they afford for the landing and shipping of goods and on account of the increased safety to the vessels, the next question considered was the best position for such docks. The projects which up to 1882 had been previously suggested are enumerated and briefly reviewed in paragraphs 8, 9, and 10 of the Report of the Diamond Harbour Dock Committee. Besides these projects of dates prior to 1882 and the Diamond Harbour Dock scheme of that year, the Committee have taken into consideration the following projects:—

(1) The proposal of Lieutenant Stiffe, Port Officer, regarding docks at Akra.
(2) The proposal of Messrs. Denham and Bayne, resuscitating a scheme of the late Mr. Power for docks at Akra.
(3) The proposals submitted to the Committee by Mr. Bruce for the construction of docks at Kidderpore and jetties at Howrah for the export trade.
(4) The proposal of Mr. F. Prestage for docks at Howrah with canal leading from Garden Reach to the docks.

Objections to Akra site for entrance.

19. Lieutenant Stiffe's project contains no information, and no details of any description, but he anticipates that the cost of the docks he proposes would be R300 lakhs. Messrs. Denham and Bayne submit drawings of their scheme, and estimate the cost at R122 lakhs; but the details of their proposals, as shown in the drawings, are not suitable for the class of vessels that would have to be worked in the dock, and no details are given of the estimated cost. There are, moreover, objections to the entrance proposed, which would render the scheme impracticable. In considering the best site for an entrance, every position must be avoided where eddies form on the flood. Docking and undocking would, as a rule, have to be done during the last two hours' flood and at slack water; and during certain tides no docking or undocking could be allowed after the tide had begun to fall. At certain seasons of the year the length of time that may be considered slack water is very short, and if a number of vessels had to be moved on one tide, the docking and undocking would have to be done entirely on the flood. But if eddies form near the dock entrance, it would not be safe to move vessels in the stream; and it is for this reason that the entrance proposed by Lieutenant Stiffe and Messrs. Denham and Bayne at the Akra bend is quite unsuitable. The eddies in this position are as bad as any in the river, and it has the further disadvantage that there is no place near the entrance where vessels could safely anchor preparatory to entering or after leaving the dock. On this subject, the Deputy Conservator and Harbour Master, Mr. Yates, an officer whose experience of the River Hooghly extends over more than 35 years, has recorded the following opinions:—

> "Undersigned has the honour to acknowledge sketch (returned herewith) of wet dock as proposed by Lieutenant A. W. Stiffe, and, in reply to Vice-Chairman's note, is of opinion that the site selected at Akra for the dock entrance is surrounded with so many natural difficulties as to render the scheme undesirable.
>
> "Though the depth of water is sufficient for the purpose, vessels cannot anchor in the neighbourhood on account of the eddy tides; the bank is not a bold one; the 12-foot line is roughly 100 feet from the dry line at its nearest point; the locality is also remarkable for a continuous eddy at all times of tide, which ceases only during the short interval between the tides (dead-slack water).
>
> "This latter, combined with the want of anchorage, undersigned considers a fatal objection, as the risk and difficulty involved in the manœuvring of vessels is quite prohibitory."

The Deputy Conservator, Port Approaches, in direct charge of river surveys, Lieutenant Petley, R.N., F.R.G.S., writes:—

> "The position marked on the plan is one of the last places I should have chosen in the whole length of the river as an entrance to a dock.
>
> "The larger mass of the ebb-tide, which in the *freshets is very strong,* sets right on to the proposed site and the eddies, except at dead-slack water, besides being very strong, also occupy the whole space about that locality, and with the fact before us of neither anchoring space nor even fair anchorage ground, I can only concur with Mr. Yates that the position chosen is prohibitory."

Similar objections urged in 1863.

20. This site for an entrance to wet docks was first suggested in 1863 by Mr. Power, Chief Engineer, East Indian Railway, and the scheme was then referred to a Committee of Experts, *viz.*, Captain Reddie, Superintendent, Marine; Captain Howe, Master Attendant; and Mr. Obbard, River Surveyor. Their opinion is recorded in the following report:—

> "On the 17th instant we inspected the site No. 1 at Akra, and anchored near the bank in four fathoms reduced low water. We then sounded in the boat, and found the water gradually shoal to two fathoms at 200 feet from low-water mark. We then landed and inspected the locality. There is abundance of available and eligible ground for excavating wet docks below the building known as Akra Farm House; but the river hereabouts is generally full of eddies; in fact it is the worst part of the river below Calcutta for a ship to ride at anchor in a strong tide; and taking this into consideration, together with the necessity that would exist during the south-west monsoon for a large number of ships to be hauled out of dock on the same day during the height of the spring tides, and the very great danger that would be attendent upon a ship riding at anchor in this reach in such tides, even for one night, the site at Akra does not appear to be one which can be recommended as eligible for wet docks."

The concurrence of opinion as to the unsuitability of the Akra site renders any more detailed discussion of Lieutenant Stiffe's proposal unnecessary. Messrs. Denham and Bayne in the concluding paragraph of their note, anticipate this as an objection from "some few opponents," and suggest an alternative site in Garden Reach for the dock entrance, with a canal two miles long leading from Matea Brooj to the dock. This alternative site at Garden Reach is more suitable for an entrance; but the Committee prefer the site which they now proceed to recommend as more convenient in every way.

Proposal to construct dock at Kidderpore.

21. There is a general unanimity of opinion that, to meet the requirements of the import trade of the port, any dock should be constructed on the Calcutta side of the river, and the Committee see no reason why the exports should not be accommodated in the same dock. It has already been shown in paragraph 12 that out of 1,798,536 tons exported during 1882-83, only 746,408 tons of that class of goods came to Calcutta *viâ* the East Indian Railway. For a portion of the exports brought down by the East Indian Railway, docks on the Howrah side would be the most convenient, so long as the Howrah station continues to be the chief terminal station for goods brought to Calcutta by that line; and the question of constructing either docks or jetties on the Howrah side of the river for the convenience of this portion of the export trade will be hereafter considered. But the Committee are of opinion that on the completion of the bridge the tendency will be to concentrate the import and export trade on the Calcutta side of the river in the same docks, and with this view the Committee recommend for adoption the construction of docks at Kidderpore, so designed as to admit of practically unlimited extension hereafter, as the trade of the port increases.

Estimated cost of site.

22. The site recommended is immediately to the south of the Government Dockyard. The entrance to the dock would be through the Government Dockyard, where it can be constructed without in any way inconveniencing the work at present carried on there. The ground behind, as far back as the old Garden Reach road, can, the Committee's enquiries lead them to believe, all be bought up for about R1,530 a bigha. There are very few masonry buildings on it worth mentioning, and it is at present covered almost entirely with small gardens, huts, and tanks, and lets for from R2 to R3 per cottah per annum. Beyond the Garden Reach Road, for a distance of about 1,000 feet, the land would be worth about R500 per bigha; but beyond this are open fields which could be acquired for about R50 per bigha.

Area of dock and accommodation provided.

23. The general arrangement of the dock is shown on the plans, but may be here briefly described. The outer dock will be 2,630 feet by 600 feet, or about 38 acres in extent, and will accommodate 14 vessels—6 berths for the largest steamers and 8 berths for sailing vessels or smaller steamers discharging at the same time. The inner dock is 4,700 feet long and 600 feet wide, and contains quay space sufficient for the accommodation of 20 steamers and sailing vessels at the same time. All the necessary crane and warehouse accommodation for working the vessels berthed in the dock has been provided for in the estimates, including a pair of sheer legs, capable of lifting 60 tons, to be erected in the tidal basin. The accommodation in the two docks would therefore be sufficient for 34 vessels; and allowing 14 days for each to discharge and load, or, say, 26 at each berth annually, the two docks could accommodate in all about 864 vessels. These vessels could all be discharged and loaded at the quay; but the docks could accommodate a much larger number by arranging for stage berths.

Dock entrances.

24. The entrance to the dock would be through a tidal basin about 600 feet by 650 feet; and from the tidal basin to the river there are two entrances—one 80 feet wide and the other 60 feet. Between the tidal basin and the dock there are also two entrances of corresponding dimensions,—*viz.*, 80 feet and

60 feet. The 60 feet outer entrance is a lock 450 feet long, but with intermediate gates to take in vessels of less than 300 feet length and light draught. Generally speaking, the gates would be opened about two hours before high water, when the water in the river and tidal basin would be at the same level; but it would often be found convenient to take in a vessel before the top of high water, and in such cases the lock would be very useful. The lock would also be required to pass cargo boats out and in at all times of tide; and during neap tides, if only a few vessels had to be handled, a considerable amount of water might be saved by locking vessels out and in instead of reducing the level of the water in the tidal basin. The plan of entrances and arrangements here described will most conveniently meet the requirements of this river and the large vessels that will use these docks, and greatly facilitate the handling of such vessels in entering or leaving the dock. The site also, as regards the river, is the best and most convenient within the limits of the port. There are no eddies to contend with, and there is a fine anchorage immediately in front and extending nearly a mile up the river.

Water over dock sills.

25. Taking Kidderpore Dock sill as datum, the depth proposed for the outer entrance and the tidal basin would be 14 feet below datum, and for the inner gates and dock 10 feet below datum. The water in the main dock would be maintained by pumping, at a level varying from 16 to 22 feet above datum, or at the level of ordinary spring tides at the different seasons of the year. The lowest neaps rise to only 11 feet above datum; but there are very few such tides, and they occur only in January and February, and in these months only for two or three days. During the remainder of the year the tides always rise to 12 feet and over, so that it would only be on three or four days in the year that a vessel drawing 24 feet of water could not enter or leave the dock. On spring tides the depth on the outer sill would never be less than 29 feet, and during the rains 36 feet. In fixing the depth of the sill at 14 feet below datum, the Committee have been guided by the fact that a greater depth would be of no practical advantage, as vessels which could not leave the dock with this depth of water over the sill could not at such time proceed down the river.

Facilities for hauling in and out of dock.

26. The entrances are placed at an angle to the stream and point in opposite directions. As vessels would generally dock before the top of high water, those about to enter would anchor above the upper entrance, and as this points up stream, it would be an easy matter to get the vessel into the dock. On the other hand, vessels going out before the top of the flood would be taken out by the lower entrance, head to the tide, and would be under command at once. Vessels entering the port at the turn of the tide would steam direct into dock by the lower entrance, and vessels leaving the dock after the top of high water would steam or haul out by the upper entrance.

Arrangements for working tidal basin.

27. The arrangements for working the tidal basin on ordinary tides would be as follows:— Immediately after the top of flood tide the outer gates would be closed and all the water in the tidal basin impounded. Assuming, for the sake of illustration, that the tide on this occasion had risen to 15 feet, and that the water in the dock was 18 feet above datum, the water in the tidal basin would then be 3 feet below the level of the water in the dock, and all the vessels that had entered on that tide would be in the basin. The sluices leading from the main dock would then be opened, and the water in the basin raised to the same level as that in the dock. This would reduce the level of the water in the docks about 4 inches, and raise the level of the basin 2 feet 8 inches, so that the water in the basin and in dock would all be at the same level, and stand 17 feet 8 inches above datum. The depth of water over the dock sill would then be 27 feet 8 inches. The gates leading to the dock could then be opened, and all the vessels that had entered the basin could be taken into the dock. Pumping would now be resumed, and the whole of the water in the basin raised to its original level, giving a depth of 32 feet in the dock and basin. Vessels ready to un-dock on the next tide would now be taken out into the basin, and about an hour before low water the gates of the dock would be closed. The scouring sluices at the outer gates could then be opened, and the water in the basin run off until it fell to the level at which the dock-master intended to commence docking on the following tide. This would generally be at the level which the tide was expected to reach 1½ or 2 hours before the top of high water, and for a rise of 15 feet would probably be fixed at 13 feet over datum, or 27 feet on the sill. If fixed at 13 feet, with the water in the dock at 18 feet, the tidal basin would have to be run down 5 feet, or to 13 feet above datum. As soon as the flood tide reached this level, vessels could be taken in or out, and the water in the basin would rise with the tide. During the cold season, when there is little silt in the river, the water might be allowed to flow in direct from the river, but during the

rains the sluices from the main dock should be opened so as to raise the water in the basin as fast as the tide rose, and so prevent, as far as possible, river-water from entering the dock.

Graving docks.

28. On the east side of the tidal basin space has been allowed for the construction of two graving docks—one 520 feet long with a 70-feet entrance, and one 375 feet long with a 60-feet entrance, the lengths given being those on the blocks. The Committee, however, only recommend the construction of the larger dock at present, and this has been provided for in the estimates. There would be a separate and distinct revenue from this dock, which the Committee hope will be sufficient to cover the charges; but irrespective of this, the Committee are decidedly of opinion that such accommodation should be provided in Calcutta, whether the direct return from the dock would be sufficient to meet charges or not, as there is at present no dock on this side of India capable of taking in the largest class of vessels now frequenting the port. Vessels using these graving docks could be most conveniently repaired from the present workshops in the Government Dockyard. But if owners preferred getting the work done otherwise, the dock could be let for the time to the firm that contracted for the work.

Connection of docks with Calcutta canals.

29. With docks at Kidderpore, Tolly's Nullah will become the main line of communication for boat traffic, and it is therefore of the greatest importance that it should be locked, and at some places deepened and widened. Plans are, it is understood, being prepared in the Public Works Department for this work and cutting a canal to connect the Nullah with the Circular Canal at Sealdah. This would place the proposed docks in direct communication with the eastern canals and rivers round Calcutta, and cargo coming into port by this means of carriage for ultimate shipment could be stored in warehouses in connection with the docks. The importance of this connection is apparent; and from a reference to the report of the Diamond Harbour Dock Committee (paragraphs 50 and 76), it will be seen that the advantages of connecting the docks with the canals were considered of sufficient importance to warrant the Committee in recommending the extension of the boat canal to Diamond Harbour. The level of the water in Tolly's Nullah and the canal would be kept at 12 feet above datum; and it is proposed that the water for the supply of the main dock should be pumped from this canal.

Water to feed docks and canal.

30. The water to feed the canal and docks would be drawn from the Hooghly at Kidderpore Bridge through self-acting sluices similar to those at Chitpore, which would only allow the surface water to enter the canal. It has been found in the tidal canals that the whole of the silt is deposited within a short distance of the entrance. This is practically what might be expected when the conditions are enquired into. The velocity of the water in the canal is so slow that it cannot retain the particles of mud in suspension, and the consequence is that the silt is deposited close to the entrance. The water for the dock would be pumped from the canal at the head of the boat dock, a distance of about 6 miles from the point at which it is drawn from the river; and water travelling slowly through a canal or silting basin (which the canal practically becomes) for this distance, will be almost free from silt before it enters the dock. This arrangement does not, of course, do away with the necessity for dredging; but the dredging will be done in the canal in a position where it will cause very little inconvenience, instead of in the dock.

Height of water in docks and arrangements for pumping.

31. The level of the water in the dock will ordinarily be maintained at heights varying from 16 to 22 feet above Kidderpore dock sill, according to the season of the year. This is on the average 7 feet above the level of the water in the canals, and the whole of the water for the supply of the dock will therefore have to be pumped on the average about 7 feet. By maintaining the water in the dock at the level of spring tides instead of allowing it to vary with neaps and springs, the level of the bottom of the dock can be kept about 5 feet higher than would otherwise be necessary, and consequently a very great saving effected in the construction of the quay-walls and excavations; but as the depth of the dock has been fixed at 10 feet below datum, the level of the water may vary, without any inconvenience to shipping, from 16 to 22 feet above datum, giving an actual depth of 26 to 32 feet in the dock. During high tides, in the rainy season, the level of the water in the dock would have to be kept at from 21 to 22 feet above datum.

Sanitary arrangements.

32. By these arrangements the water in the dock would be kept constantly changed, and all the disadvantages that might arise if the water were stagnant would be avoided. In connection with this question, the Committee have taken into consideration the sanitary arrangements which would have to be made for working the docks. Latrines and urinals, properly constructed, flushed and drained, would be placed at convenient distances round the dock; and all water-closets and urinals on board ship would be kept locked and properly secured so long as the vessel is in dock. For the

removal of sweepings, ashes, cooking refuse, &c., conservancy boats and trucks would be maintained. With these arrangements strictly carried out, and the water of the dock constantly changed by pumping and discharging, there will be no risk of the water ever becoming foul or in any way prejudical to health. The practical experience gained in the working of docks at Bombay shows that the fears formerly expressed as to the prejudicial effect of docks on the health of the crews of vessels and the surrounding neighbourhood are entirely groundless, and with the sanitary arrangements now proposed for the docks in Calcutta, the Committee feel confident that no fears need be entertained on this account.

Sections of ground at site.

33. In the plans submitted herewith, sections of the ground at Kidderpore are given, and it will be seen that they vary considerably. At some places it might be possible to get in the dock walls dry, but at others it would not; and in estimating the cost it has therefore been considered advisable to assume that the locks and quay-walls throughout will have to be constructed on wells. If wells are not found necessary, there will be a considerable saving; but in estimating it is best to allow for the maximum expenditure that may have to be incurred.

Disposal of excavated soil.

34. As regards the spoil from the docks, a portion of it would be required to raise the land taken up for the dock enclosure to 26 feet above datum, the greater part of the land not being now more than 20 feet above datum. The excavation from the tidal basin and lock entrance, and a great part of the excavation from the outer dock would be required to raise the foreshore lands between Tolly's Nullah and Fort Point, and for the disposal of the remainder of the excavations land would have to be taken up to the south of the dock premises. This land is very low, and is swamped during the rains. It would improve these lands to raise them, and on completion of the works they would certainly sell for more than it would cost to acquire them. The Committee do not therefore consider that the land for spoil would add at all to the ultimate cost of the works.

Outer dock appropriated for vessels bringing imports.

Salt trade.

35. The outer dock, marked on the plans Dock No. 1, is primarily intended for vessels bringing imports and loading export cargoes, but, of course could be used also for vessels only loading exports. In the inner dock, No. 2, a frontage of 2,200 feet is set apart for the discharge of salt-ships, and here large warehouses, specially designed for salt, will be constructed. The plans show six such warehouses, each divided into nine compartments; but in the estimates provision has only been made for the construction of five compartments, which altogether will be capable of accommodating about 50,000 tons of salt. Ample room has been left for adding to these warehouses as the demands of the trade show extension to be necessary. The landing charges would cover werehouse rent for one month, at the expiration of which the salt would incur wharf-rent if not removed; but private warehouses or public warehouses, if considered necessary, can be constructed immediately behind the dock warehouses, where sufficient space has been reserved, and in these the salt could remain for any length of time at a charge not exceeding ordinary salt warehouse rents. For the delivery of the salt either by railway or boat the arrangement of the dock would be found very convenient. The railway lines pass immediately behind the warehouses, and beyond the railway there is a boat dock where native boats could lie and receive their salt, and then proceed direct to the eastern districts by canal without ever going into the Hooghly. These arrangements would also prove a great convenience to the ship, and enable her, if desirous of doing so, at once to get rid of her cargo and all liability in connection with the salt. Instead of discharging only 60 or 70 tons per day, as is the present practice, she could complete her discharge and be ready to take in export cargo in about a week.

Coal trade and ballast ships.

36. Accommodation for the coal trade is also provided in the docks. The abstract of imports given in paragraph 10 shows that 75,513 tons of coal were last year imported into Calcutta. This trade is now worked entirely by boats; but it is proposed to appropriate a quay space of about 1,500 feet for the use of vessels discharging coal and ballast. All coal could be discharged at this wharf, and if found convenient, steamers might be taken here to coal before leaving the docks Ballast would also be discharged at this quay, and arrangement made for its removal by railway trucks to ballast depôts immediately behind. Where the coal wharf is to be constructed it is now open fields, and any quantity of land can be had there for R50 or R60 per bigha. The remainder of the quay space in the inner dock is arranged for exports, with large sheds at each berth for the collection of cargo.

Spare land available for private warehouses.

37. In connection with these docks, the opportunity will be afforded of providing space for the construction of large warehouses, both public and private, in close proximity to the docks and shipping, and in direct communication with the entire railway system. The necessity for such accommodation has long been felt, and it will be a great convenience to

merchants to have space provided close to the wharf for the construction of warehouses in which cargo can be collected and assorted. It is therefore proposed to take up a strip of land about 250 feet wide on both sides of the dock and the whole length of the dock enclosure for his purpose, and to lease or sell such land for the construction of private godowns. Between the dock sheds and these private warehouses a space would be left of 150 feet, but the private warehouses would be connected with the lines at the dock warehouses by crossings at short intervals. The lines behind the dock sheds would be for the use of the wagons containing produce for direct shipment, but a double line of sidings would be carried along the front of the private warehouses, so that goods could be taken direct from the railway wagons into the private godowns of the merchants.

Convenience of connection between docks and jetties, &c., by tramway.

38. It is proposed that the docks at Kidderpore shall be connected with the jetties and the inland vessels' wharves by an extension of the Commissioner's Tramway from Chandpaul Ghât direct along the river-side to Kidderpore. To obtain room for a double line of rails, it will be necessary to widen the present road by constructing a retaining wall about half-tide level, in the same manner as has already been done opposite the landing stage at the end of Outram Road. For a short distance above and below Fort Point the tramway would have to be carried on iron piles; and at Fort Point it would be necessary to remove the monument so as to give the necessary room for the tramway to pass. The construction of this embankment outside the present Strand Road would be a great improvement to the drive, and allow of its being considerably widened both above and below Fort Point, while it would add very much to the appearance of the frontage as seen from the river; and the traffic could be worked under regulations which would prevent all fear of it ever becoming a nuisance to those who use the Strand in the evening for purposes of recreation. From Chandpaul Ghât to the north end of the carriage stand at the Eden Gardens and from Prinsep's Ghât to Tolly's Nullah, wharves for inland vessels might be constructed, and this is provided for in the estimates.

Direct connection between docks and jetties an essential part of scheme.

39. It is an essential part of the scheme that this connection should be carried out. With the tramway connecting the docks at Kidderpore with the jetties, it will be an easy matter to convey goods to the warehouses now being built at the jetties, and it would only be a matter of a little extra haulage to take tea from the proposed new tea warehouse at Armenia Ghât to the import dock at Kidderpore instead of to the jetties. In both cases the tea will have be to be loaded into trucks to convey it from the tea warehouse to the wharf, but it would manifestly be very inconvenient to take tea to the docks without a direct tramway along the Strand Road. With this connection, Armenian Ghât is the best site for the tea warehouse, and it is the most convenient site for those engaged in the tea trade.

Financial result of proposed works.

40. The financial returns, which may be estimated as resulting from the proposed docks at Kidderpore, have now to be considered, and to arrive at these, the following method has been adopted. The gross capital on the existing and the proposed works has been calculated in the following manner:—

	R
Capital debt of town jetties and appliances already constructed	26,00,000
Estimated expenditure on dock at Kidderpore	2,23,30,105
Extension of tramway from jetties to the docks	7,44,000
TOTAL	2,56,74,105

Based on the actual returns of 1882-83.

41. Assuming that the whole of this capital had been expended, and that the works had, been completed and made available for the requirements of the trade of the port during the year 1882-83, a careful analysis of the returns given in paragraphs 6 to 10 of the shipping, and the import and export tonnage of that year, will show, with a very close approximation to an accurate estimate, what income the Port Trust would have secured from the works. This estimate may be taken under the two heads of Imports and Exports.

Income from imports.

42. In the Commissioners' Administration Report will be found the actual receipts of the jetties for the year, showing that from the 199 ships accommodated, the revenue from imported goods, excluding that from shipping exports on to those vessels, and which will be included in the return from

exports, amounted to R6,79,000. Besides the 199 ships at town the jetties, the following vessels could have been accommodated in the new docks with berths for discharging cargo:—

33 ships of	52,382	tons gross,	47,886	tons net,	bringing	72,617	tons of	iron.
40 „	62,473	„	57,140	„	„	75,513	„	coal.
174 „	259,139	„	234,171	„	„	326,555	„	salt.
Total 247 ships of	373,994	„	339,497	„	„	474.687	„	cargo.

The whole of the ships bringing iron would discharge in the dock or at the jetties; but the Committee are of opinion that, even had the docks been constructed, it would have suited the convenience of some of the vessels carrying coals and salt to discharge their cargoes in the stream. A large quantity of the coal brought by such vessels is imported for the use of steamers engaged in the coasting trade, a class of vessels which would not probably use the dock; and it would not, therefore, be convenient for vessels bringing coal for these steamers to discharge in the dock. The Committee estimate that the quantity of coal imported for this purpose is about 30,000 tons annually, so that only 45,513 tons of coal can be taken into account in calculating the probable receipts from landing charges on coal. In the case of salt, it is very probable that when the imported cargoes are on owners' account, and the demand for freight is slack, it will suit the convenience of the owners to keep the salt on board, and the Committee cannot, therefore, count upon the whole quantity above shown being discharged in dock. They consider, however, that the landing charges on 200,000 tons of the total quantity imported may be safely included in the estimate of receipts from imports. The number of vessels and tonnage of imported cargo to be taken into account after making these corrections would therefore be as follows:—

33 ships with	72,617	tons of	iron.
24 „	45,513	„	coal.
116 „	200,000	„	salt.
173	318,130	„	cargo.

These 173 vessels would pay for the accommodation allotted to them at the rate now paid for the use of the jetties. The average amount paid by each vessel last year as jetty-hire was R390, and taking the average tonnage as 1,889, this was equivalent to a charge of 3·3 annas per ton. The average paid as mooring-hire was about R150 for each vessel, which taking the average tonnage at 1,889, gives the rate per ton at 1·3 annas. The total amount paid by vessels using the jetties is therefore 3·3+1·3=4·6 annas, or, say, about 4½ annas, and this is all that vessels using the dock would pay direct to the Commissioners; the balance required to meet interest and working expenses would be met from the charges levied on the goods. At this rate, and taking the actual average net tonnage of these vessels, which was 1,375 tons, the 173 vessels would have paid, at 4½ annas per ton, R66,912. From the cargo the receipts are estimated, in the case of iron and coal, at the jetty rates of landing, *viz.*, R1 and annas 10 respectively per ton. For salt there is no rate enumerated in the jetty schedule, and the Committee have adopted a rate of R1 per ton to cover landing and free storage in the warehouse for one month. This rate was assumed in previous schemes submitted to the Port Commissioners for the accommodation of this trade after careful enquiry of what the trade could afford to pay. These data give the following income:—

	R
From imports at jetties (ships and cargo), actual	6,79,000
„ 173 additional vessels	66,912
„ landing 72,617 tons of iron	72,617
„ „ 45,513 „ coal	28,445
„ „ 200,000 „ salt	2,00,000
Total from imports . .	10,46,964

Income from exports.

43. In estimating the income from exports, there would have been the following vessels to load, excluding all coasting and China traffic:—

			Net register tons.
Ships which discharged at jetties	199	of	375,907
„ „ brought iron, coal, and salt	247	„	339,497
„ „ „ horses	11	„	14,765
„ „ „ petroleum	27	„	37,179
„ „ „ ballast	335	„	386,841
Total . .	819		1,154.189

The payment on account of the vessels is, in the case of ships bringing imports, included in the return from imports, as 4½ annas per ton is assumed to cover all dock or jetty charges against the vessel so long as she is discharging and loading. For ships which go into the docks, or come to the jetties only to load, the charge for the accommodation may be taken at two-thirds of that made against vessels using the docks for discharging and loading. The number of such vessels may be estimated at 447, *viz.*, the 373 vessels above enumerated as bringing horses, petroleum, and ballast, plus the 74 vessels bringing coal and salt and discharging their cargoes in the river instead of in dock. The Committee would, however, in the case of exports, also make an allowance to cover a class of vessels which may prefer to load as well as discharge in the stream, and this deduction they have calculated as 10 per cent. on the above number of 447, leaving a balance of 403 vessels. The return from exports should therefore be (1) payment by 403 vessels of 486,482 tons net register, at 3 annas per ton, or R91,215; and (2) the payments made by the shippers of export cargo. The shipping charges on the cargo have been estimated at R1 per ton all round, and in fixing this rate it has been borne in mind that the very lowest charge at which any export cargo can be shipped is R1 per ton, while on many articles cost of shipping is in excess of this amount. At the same time shippers of grain and seeds calculate that a considerable loss is incurred from pilfering, damage, and rough handling in cargo boats between the wharf and the ship's hold.

Cargo taken into account for shipment.

44. The cargo to be handled in the docks and at the jetties has been abstracted from the figures given in paragraph 11. This abstract includes all the cargo shipped to the United Kingdom, Continental Europe, Africa, United States, West Indies, South America, and Australia. It includes no cargo shipped for China, Straits, Burma, Ceylon, or Indian ports, although no doubt some portion of the Ceylon and Madras coast shipments is carried in vessels which clear out for the United Kingdom *viâ* Madras and Colombo. To make an estimate on the safe side, no Coasting, China, Burma, or Ceylon tonnage is, however, included.

	Tons.
United Kingdom	896,455
United States of America	148,642
Continental Europe	102,762
Africa and Islands adjacent	84,303
West Indies and South America	53,202
Australia	38,784
Total	1,324,148

From this tonnage the Committee think it advisable to make a deduction of 10 per cent. to meet the case of vessels continuing to load in the river, and of vessels loading in dock but taking in part of their cargoes from boats, and the receipts from export cargo are, therefore, estimated on 1,191,734 tons. The receipts on this tonnage at R1 per ton would therefore be R11,91,734, and R91,215 the dock charges on the vessels which loaded, or R 12,82,949 in all.

Total receipts from imports and exports.

45. The capital expenditure includes the cost of about 2,000 cottahs of land which will be available to rent out for the construction of private warehouses, in close proximity to the docks. This land will no doubt hereafter realise as large rents as are now obtained for lands on the Strand bank property, or R10 per cottah per mensem; but it would not be safe to assume that this rate will be realised in the first instance. A rental of R5 per cottah per mensem, equivalent to an income of R10,000 monthly, or R1,20,000 annually, has therefore been included in the estimate on this account. On boats entering the boat dock to discharge or load cargo, the usual wharfage charge of annas 2 per ton would be realized, and estimating this tonnage at 600,000 tons annually, the additional income to be derived from the boat dock would amount to R75,000 per annum. The total income of the jetties and dock during 1882-83, had the works the Committee have recommended been in operation, would therefore have been as follows:—

	R
Imports	10,46,964
Exports	12,82,949
Rent of lands	1,20,000
Wharfage from boat dock	75,000
Total Receipts	25,24,913

Expenditure involved.

46. Against this income the approximate expenditure would be as follows :—

	Actual for jetties.	Additional for docks.	TOTAL.
	R	R	R
For control, head office, engineering	37,974	30,000	
Supervision	27,898	60,000	
Shed and establishments for receipt and delivery	78,293	1,25,000	
Coolies, sorters, gunners, and working expenses	88,478 31,364	2,84,397	
Cranes	25,547	50,000	
Repairs	42,892	85,000	
Municipal taxes	32,400	30,000	
Police guards	8,304	12,000	
Lighting	4,050	12,000	
Dredging and pumping	11,000	50,000	
Total	3,88,200	7,38,397	11,26,597

Surplus income available for interest.

47. Deducting this sum of R11,26,597 from the above income of R25,24,913, leaves a balance of R13,98,316 to meet the charge for interest and sinking fund. In respect of expenditure on jetties, this charge would amount to 6½ per cent.; but in regard to the docks, the Committee are of opinion that the sinking fund should not be provided; only the interest charge should be required in respect of works of a permanent character, such as docks. The amount required on the capital expenditure would be—

	R
On R26,00,000 capital debt of present jetties at 6½	1,69,000
On R2,30,74,105 capital debt of proposed docks at 4½	10,38,335
Total	12,07,335

Net profit.

48. The surplus after meeting all charges would then be as follows :—

	R	R
Total income		25,24,913
Expenditure	11,26,597	
Interest and sinking fund	12,07,335	
		23,33,932
Surplus		1,90,981

Prospective income works will secure if trade increases.

49. The above are the estimated financial results based on the actual trade of the port for the year 1882-83, but the works which the above capital outlay will cover could, without having to resort to stage berths, accommodate 1,064 ships, *viz.*, 864 in the docks—allowing an average stay of fourteen days for each vessel—and 200 vessels at the town jetties. The income from imports and exports of R23,29,913 was obtained from handling 372 vessels for the purpose of discharging and loading, and 403 vessels for the purpose of loading only, or 775 vessels in all, 289 vessels less than there would be accommodation for when the docks are completed. The receipts from 775 vessels give an average return of R3,006 from each vessel. At this rate the additional income to be derived from the 289 additional vessels which the docks are capable of accommodating would amount to R8,68,734.

Income from additional vessels.

50. The return given at page 14 of the Port Trust Administration Report for 1882-83 shows the following as the tonnage of vessels entering the port during the past five years:—

Years.	Arrivals.								
	Number.			Gross Tonnage.			Net Tonnage.		
	Steamers.	Sailing vessels.	Total.	Steamers.	Sailing vessels.	Total.	Steamers.	Sailing vessels.	Total.
1878-79 . .	489	478	967	898,932	531,857	1,430,789	583,535	531,857	1,115,392
1879-80 . .	442	454	896	848,564	567,415	1,415,979	551,872	551,141	1,103,013
1880-81 . .	506	478	984	1,009,052	570,817	1,579,869	666,213	554,333	1,220,546
1881-82 . .	601	473	1,074	1,243,680	564,325	1,808,005	829,983	547,416	1,377,399
1882 83 . .	619	532	1,151	1,342,213	639,974	1,982,187	888,886	621,458	1,510,34

There is nothing before the Committee to make them doubt that the trade of the port will continue steadily to increase. Indeed, should the expectations of Mr. Bradford Leslie, Agent, East Indian Railway Company, as expressed by him in the memorandum adopted by his colleagues of the Diamond Harbour Dock Committee (*vide* paragraph 17 of their report), be realised, and his line alone, on the completion of the Hooghly Bridge and the opening out and further development of the numerous tributary lines feeding the East Indian main line be "pouring in country produce, excluding coal, at the rate of 1,250,000 tons per annum," the accommodation now proposed will have to be still further increased. During the first four months of the current year, 1883-84, the gross tonnage of the vessels entering port was 795.653 tons, against 610,380 tons, the tonnage of the corresponding four months last year. The statistics given in paragraph 9 show that the tonnage of the chief staples of export increased from 1,247,298 in 1878-79 to 1,798,536 tons in 1882-83, or about 44 per cent, Taking this into account, and the rapid increase of the past two years, it may be assumed that the increased number of vessels estimated for in paragraph 49 will require accommodation by the time the docks are finished, and the income to be derived from the docks and jetties would then be as follows:—

	R
Income based on returns of 1882-83	23,29,913
" from 289 additional vessels	8,68,734
" from spare land and boat dock	1,95,000
Total .	33,93,647

Expenditure on additional vessels.

51. To work the additional 289 vessels will of course involve an addition to some of the items in the above estimate of the expenditure for working the 775 vessels for 1882-83. This addition is shown in the following statement:—

Particulars.	Jetty, 199 vessels.	Dock, 576 vessels.	Extra 289 vessels.	TOTAL.
	R	R	R	R
Control, head office, engineering	37,974	30,000	...	...
Supervision	27.898	60.000	15,000	...
Shed officers' establishments for receipt and delivery .	78,293	1,25.000	50,000	...
Labour and working expenses	1,19,842	2,84,397	1,42,800	...
Cranes	25,547	50,000	25,000	...
Repairs	42 892	85,000	10,000	...
Municipal taxes	32,400	30,000	...	...
Police guards	8,304	12.009	2,000	...
Lighting	4,050	12.000	3,000	...
Dredging and pumping	11,000	50,000	...	...
Total .	3,88,200	7,38,397	2,47,800	13,74,397

Net profit on working 1,064 vessels.

52. The following abstract shows the probable net results on the completion of the two docks:—

	R	R
Income	...	33,93,647
Expenditure, working expenses	13,74,397	
Interest, sinking fund	12,07,335	
		25,81,732
Surplus . . .	...	8,11,915

The foregoing estimates show that the present trade of the port would give much more than a sufficient return to cover all working expenses and interest on capital expended for the construction of the works proposed, and if the trade of the port increases, as it has hitherto done, and to such an extent as to utilise fully the accommodation which the proposed expenditure will provide, the receipts will be very much increased without adding anything to the expenditure for interest, and only a comparatively small amount to the working charges.

Docks at Howrah proposed and objected to.

53. The Committee pass on to the question of constructing a dock on the Howrah side of the river for the special convenience of the export trade, and after giving the question their full and careful consideration, they are not in favour of constructing docks on both sides of the river. It would entail on many merchants double establishments, and great inconvenience in the working of vessels loading general cargoes. The only ground upon which the construction of docks at Howrah could be preferred to their construction on the Kidderpore site selected by the Committee, would be that goods brought to the latter place would incur a heavier charge for railway freight than goods delivered at docks in Howrah; but the Committee have been assured on good authority that such would not be the case. Calcutta and Howrah will both be terminal stations of the line, and for all practical purposes are at the same distance from the export marts of the upper provinces. It seems to the Committee that an increase in charge could not be made without putting Howrah and Calcutta into competition as shipping ports while they are practically the same place. The direct communication which the railway bridge accross the Hooghly will afford, will give to the great bulk of the exports brought by the East Indian Railway all the facilities which now exist in Calcutta, and the Committee believe that the tendency will be to concentrate the trade in Calcutta. The expense to be incurred to give to the exports brought down by the East Indian Railway the benefit of all the advantages provided in Calcutta must be borne equally by the whole trade, and should not be made a separate charge on goods brought to Calcutta. This principle has practically been in force for the past ten years, as all goods brought down by the East Indian Railway contribute one rupee per hundred maunds towards the maintenance of the Hooghly floating bridge, whether the bridge is used by the goods or not. In view also to the possible connection with the Mutlah, the Committee cannot recommend the expenditure of a large sum of money on docks at Howrah. Kidderpore Docks can be extended to meet any

increase in the trade of the port, and such extensions can be constructed at much less cost than a separate dock with separate entrances on the Howrah side of the river. To construct a dock 4,000 feet long, and with a canal from below the Botanical Gardens, so as to make the dock close to the railway station, as proposed by Mr. Prestage, would cost about 140 lakhs, while to extend the Kidderpore Docks so as to give the same accommodation would not cost more than 80 lakhs.

Additional facilities at Howrah for the export trade.

54. The extended accommodation now being provided at Howrah and the terminus of the East Indian Railway will, it is expected, do much to supply the immediate wants of the export trade, and it is hoped that by the time the trade expands beyond this extra accommodation, the new docks will be ready for use. The Committee are fully sensible of the urgent need of affording the earliest possible relief to the export trade of the port, and in this view they have carefully considered the advisability of erecting jetties or providing pontoons at a site below the Botanical Gardens; but having regard to the extension of accommodation now being carried out by the Railway Company, and to the further extensions which can be carried out on the Port Commissioners' wharves at Howrah, between the Railway Company's premises and Shalimar, the Committee have not included in this report any recommendations in regard to the works proposed below the Botanical Gardens. The Committee desire, however, to urge strongly upon the Port Commissioners the important advantages which the export trade would derive from the very early completion of the reclamation of the foreshore land north of Shalimar Point. The Committee are of opinion that the reclamation of this land should be pushed on at once, and concurrently with the works on the new river-side road along the foreshore, and every endeavour made to have the work sufficiently advanced for the erection of large sheds for the convenience of exporters, and the connection of these sheds by a railway siding along the road and into the Howrah goods terminus by the commencement of the next grain-exporting season. Should these extensions not prove sufficient for the trade, there is ample space for sheds and pontoons below the Botanical Gardens at Garden Reach, where an export wharf with sheds, &c., might be constructed, and to which the East Indian Railway Company might extend their lines. This would enable vessels lying at the Muttea Brooj moorings to be loaded from the Garden Reach wharf, and pontoons as conveniently as ships in the Calcutta moorings take their cargoes from the Howrah pontoons.

Position of Railway Bridge across the Hooghly.

55. In considering the several proposals for adding to the accommodation of the port, the great inconvenience that will be felt if the bridge connecting the East Indian Railway with the eastern bank of the river is constructed at Hooghly, has been brought prominently to the notice of the Committee; and it appears to them that no scheme of port improvement can be complete without a railway bridge as close to Calcutta as possible, connecting the docks and railways on the east and west banks of the river. Without a railway bridge at Calcutta any extension of railway communication in the direction of Midnapore, or of the districts south and west of Howrah, will be entirely cut off from all the conveniences provided in the proposed docks at Kidderpore, except by making a detour of about 42 miles to cross by the bridge at Hooghly. The Hooghly site is too far above Calcutta to be of any use in working the port, and it is not far enough north to give the greatest benefit to the trade with Eastern Bengal. A bridge at Kulnah, as originally proposed by Colonel Stantons and which would be in the direct line of the new Central Bengal Railway, would be more useful for this purpose, and would also shorten the distance between the coal-fields of Raneegunge and the stations on the Ganges and Brahmapootra.

Position at Hooghly objected to by present railway officials.

56. The plans attached to the scheme submitted by Mr. Denham, the present Chie Engineer of the East Indian Railway, show that he considers the bridge should be at Cossipore—a position which this Committee, speaking for the convenience of the port, would entirely approve. Mr. Power, Mr. Turnbull, and Mr. Sibley were also of opinion that the bridge should be close to Calcutta; and Mr. Rendel, the Consulting Engineer to the Company, at one time held this opinion very strongly, as the following extract will show:—

Extract from a letter from MR. A. M. RENDEL, *to the Secretary, London Board, East Indian Railway Company,—dated the 2nd August 1864.*

"The proposal made by the Eastern Bengal Railway Company is to construct the bridge at a point about 30 miles above Calcutta.

"The effect of crossing the river at this point would be the transfer of the whole of the through passenger and the great bulk of the mineral traffic of the East Indian Railway for the terminal length of 30 miles to the Eastern Bengal. In the event of the Mutlah being made use of by shipping, or of docks being constructed on the Calcutta side of the river, the whole of the East Indian goods traffic would be similarly lost to that Company.

"In fact, the traffic over these 30 miles of the East Indian Railway would be reduced by a bridge on such a site to local passengers and goods only, and the vast sum which has been expended on this length would be practically thrown away.

"The compensation which the East Indian Railway Company are to receive for this vital injury is a supposed increase of £1 per mile per week over the remainder of their line, due to the increased facilities which the bridge will offer for traffic. I need not remark that this advantage would result from a bridge on any site, and that, inasmuch as the bridge may be placed where no diversion of the traffic would ensue, the traffic which it will create can only be considered as the compensation for its cost, and not for the loss which any diversion of traffic would occasion.

"As regards the public, there can be no question that the bridge should be so placed as to give it the full advantage of the railways on each bank of the river.

"The inhabitants of Calcutta are as likely at least to avail themselves of facilities for living at a distance from the city as the inhabitants of cities in other countries, and if they are cut off from the Howrah shore by the river, there can be no question that practically one bank of the river will be lost to them."

Position close to Calcutta preferred.

57. In 1862, Mr. Turnbull made borings in the river at Pultah. Comparing these with the borings made in 1855-56 on the banks of the river at Calcutta, he says :—

"I have little doubt that a proper investigation would show that a bridge could be constructed in as close vicinity to Calcutta as the shipping interests of the port would permit at a cost which the importance of the object to be gained will fully justify.

"Such a bridge could meet every object which the interests of the Government and the public require to be kept in view.

"At the same time it would prevent the loss of the enormous sum which has been spent on the first 30 miles of the East Indian Railway, the whole of which are doubled, and would save the cost of doubling and otherwise extending the Eastern Bengal Railway; and I trust that the Government will assent to the construction of no other."

Next to providing proper docking accommodation, the construction of a railway bridge as close to Calcutta as possible would offer the greatest advantage to the trade of the port. Any extra cost which a change in site would involve would probably be more than met by the change obviating the necessity for doubling the Eastern Bengal Railway line between Nyhatty and Sealdah. The Committee feel confident that, with the constantly increasing traffic, should the bridge be placed on the site now proposed at Hooghly, before very many years have passed, a railway bridge close to Calcutta will become an absolute necessity. It seems to the Committee a pity that the cost of two bridges should be incurred, when one bridge placed on a suitable site in the immediate neighbourhood of Calcutta would suffice. The objections that have been from time to time urged against placing a bridge in the position now recommended on account of the risk to the structure which would be incurred in the event of a cyclone causing ships to break adrift, will, in the opinion of the Committee, have no longer the same force, as the construction of wet docks will very materially diminish this risk. This question is, the Committee are aware, not one which has been referred to them for consideration, and they do not therefore propose to enter on any detailed discussion of the various projects which have from time to time been put forward; but it is one, in their opinion, of such vital importance to the general prosperity of the town and port, that they would urge the Commissioners to use their influence with the Government to press for a reconsideration of the subject.

Diamond Harbour dock scheme.

58. It does not fall within the province of the present Committee to enter into any detailed criticism of the proposals submitted to Government by the Diamond Harbour Dock Committee, but the question of the accuracy of the data on which the financial results of such schemes are based is of such extreme importance, that the Committee trust they will not be considered as having gone beyond the scope of their enquiry if they refer to what appears to them to be an important omission in the estimates on which the Diamond Harbour Dock scheme has been worked out, and also to one or two points in which there are errors seriously affecting the comparison made between the cost to a vessel at Diamond Harbour and in Calcutta. In comparing the charges against vessels using the Diamond Harbour Docks with those against vessels coming to Calcutta, the latter are debited with the present port-due of one anna per ton, the former are not charged anything for port-dues. The Committee appear to have overlooked the fact that port-dues are levied to keep up the lighting, surveying, and buoying of the Sandheads and channels of the Hooghly, and the cost of this amounts to over R4,00,000 annually. The full rate of port-dues allowed by law is four annas per ton, but this was never sufficient to cover the whole expenditure, and for many years past 15 per cent. of the money collected as pilotage was transferred to the credit of port-dues to make up the deficiency on this account. Without this it would have been necessary to increase

the port-dues from four annas to six annas, and a proposal to this effect was submitted to the Government of India by the Government of Bengal with a view to amending the Act so as to enable a charge of six annas per ton to be made for port-dues. That this increase was not made was due to the fact that the Port Commissioners came forward and contributed from heir surplus revenue the equivalent of the 15 per cent. formerly taken from pilotage, and enabled Government to reduce the rates of pilotage all round by 15 per cent. The reason why vessels now only pay one anna is that the Port Commissioners, after taking over charge of the port approaches, increased the contribution from general revenues so as to make up the difference between the actual cost of lighting, surveying, and buoyage, and a port-due of one anna per ton. To a ship discharging at Diamond Harbour and not contributing to the revenue of the Port Trust, the full port-due of four annas would be charged, and also 15 per cent. more for pilotage, equivalent to an additional two annas per ton. The comparison should, therefore, properly have included a charge of six annas per ton for port-dues in the Diamond Harbour Dock account, as against one anna per ton charged in the accounts of vessels discharging in Calcutta. This item alone, in the case of a steamer, exceeds by R254 the amount which the Committee show in paragraph 43 of their report as the saving which would accrue to a steamer terminating her voyage at Diamond Harbour.

Savings claimed in pilotage.

59. In paragraph 33 of the report it is estimated that the saving in pilotage by stopping at Diamond Harbour would be R411 for a steamer of 3,000 tons, and R378 for a sailing vessel of 1,600 tons. From the schedule of pilotage charges sanctioned by Government, the actual pilotage charges of two such vessels at the draught specified, from sea to Calcutta and from Calcutta to sea, would be R1,084-8 and R909 for the steaming and sailing vessel, respectively. By the same schedule the pilotage for the same vessels from sea to Diamond Harbour and from Diamond Harbour to sea would be R813-12 and R682-8, respectively. The correct saving in pilotage should be, therefore, R270-12 for the steamer and R226-8 for the sailing vessel, instead of R411 and R378, the amounts claimed as savings by the Diamond Harbour Committee.

Cost of landing and delivery of goods at Diamond Harbour and Calcutta.

60. It has been shown that in the event of the docks being constructed in Calcutta, and the Commissioners having the handling of all the goods, an all-round rate of about R1 per ton would, after paying all working expenses, provide sufficient balance to meet the interest and sinking funds on the dock scheme without calling upon the vessel to pay more than 4½ annas per ton as dock-dues, or exactly the same as is paid now for the use of the jetties. It is not quite clear from the report of the Diamond Harbour Committee whether it is intended that the 14½ annas per ton at which they have calculated dock-dues is to be paid entirely by the vessels, or partly by the vessels and partly by the consignees of cargo. Ultimately no doubt the goods have to bear the charge, but it is a matter of great importance to settle in the first instance how the charge is to be apportioned between the vessel and the goods. It is clearly shown by the estimate of establishment required to work the dock, that it does not include the cost of establishment for supervising the discharge of the vessels, tallying, and sorting cargo in the sheds, nor does it include coolie labour, nor the interest on the cranes, sheds, and tramways, which are estimated in paragraph 75 of the report to cost R28,52,500. The interest on this amount would involve an extra charge of about three annas per ton on the goods landed or shipped. The supervising and tallying establishment would require an addition of at least three annas per ton, and for handing the cargo in the wharf, there would be an additional charge of six annas per ton for imports and four annas for exports, or an average of five annas per ton. These charges would make an addition of eleven annas per ton on the cargo all round. So that the actual cost of loading and discharging cargo in the Diamond Harbour Docks would have been 14½ + 11 annas per ton, or R1-9-6 per ton all round. In addition to this, the cost of carrying the goods to or from Calcutta would be R1 per ton, so that the total cost of landing the cargo in Calcutta would R2-9-6 per ton. This charge of one rupee per ton for carriage between Calcutta and Diamond Harbour was specially pointed out in paragraph 72 of the Diamond Harbour report, for although the Committee doubted whether goods passing direct through Calcutta to or from Diamond Harbour would incur any additional railway freight, they were expressly of opinion that for goods warehoused in Calcutta the charge of one rupee per ton would undoubtedly be incurred. That this is not an unimportant item will be apparent by a reference to the statement given in paragraph 12 of this report, from which it will be seen that even if the whole of the produce brought by the East Indian Railway line to Calcutta during 1882-83 had been taken direct to Diamond Harbour for shipment, there would have remained over a million tons of exports to incur the additional charge. The actual difference,

therefore, between landing or shipping goods in Calcutta and at Diamond Harbour would be R2-9-6, less R1-4-6, or R1-5.

Rate per ton based on a certain number of vessels.

61. It should be pointed out that the rate of 14½ annas per ton fixed by the Diamond Harbour Committee was based on the assumption that 156 steamers and 312 sailing vessels, or 468 vessels in all, would use the Diamond Harbour dock. This number, the present Committee consider, is as large a number as could be safely calculated upon to stop at Diamond Harbour, seeing that the port of Calcutta would be working in competition with the Diamond Harbour docks. With a less number of vessels than 468 using the dock, the rate per ton would be increased; but if it is admitted that that number would use Diamond Harbour, the rate of 14½ annas per ton would be necessary on the Committee's own showing to cover expenses. The Calcutta rate of 4¾ annas per ton is based on the larger number of vessels included in the estimates as stated in paragraphs 42 to 49.

Comparison of actual cost to vessels using Diamond Harbour and Calcutta.

62. To enable docks at Diamond Harbour to compete with docks in Calcutta, it must be shown that the extra charge of R1-5 per ton mentioned in paragraph 60 can be met from the savings effected by stopping the vessel at Diamond Harbour; but a steam-vessel discharging and loading at Diamond Harbour, instead of saving, would incur charges in excess of the charges incurred under existing circumstances at the jetties in Calcutta. Besides the gain claimed on account of the vessels terminating the voyage at Diamond Harbour, there was also claimed a saving of R1,120 in the case of a steamer, and R462 in the case of a sailing vessel, in consideration of the accommodation provided there for discharging and loading being docks, as compared with jetties and cargo boats in Calcutta. If docks are provided in Calcutta, these savings of R1,120 and R462 must be eliminated from the calculation, and the comparison restricted to the charges for use of docks at both places.

General objections to Diamond Harbour scheme.

63. The pecuniary advantages claimed for the Diamond Harbour project, therefore, disappear; and there is no set-off against the disadvantages of the site, distance from the centre of business, want of water, drainage, &c. So long as vessels can get to Calcutta, the only ground upon which any scheme for removing the general trade from the port can possibly rest must be that of cheapening transit charges by a very important reduction in the charges against vessels, and this the docks at Diamond Harbour will not do. In a note by Trevor, R.E., which is one of the papers referred to the Committee for consideration, he says:—

> "But if we are to be content to go on as we are, and merely expand existing arrangements, there can be no doubt that we shall never succeed in making Calcutta a cheaper port; and that is perhaps the thing most to be desired."

As to the desirability of doing everything possible to reduce the charges in handling cargo, and also the charges on the shipping of the port, the Committee entirely concur. They cannot, however, accept the conclusion arrived at by Colonel Trevor, that this end is to be secured by leaving the appliances and accommodation now available in the port itself, and which may hereafter be added to, and starting an auxiliary port at Diamond Harbour. The appliances which have already been constructed have proved advantageous to the import trade and yielded at the same time a margin of profit, from which, as has been pointed out in a previous paragraph, the Port Commissioners have been able to make a reduction in port-dues and pilotage. This profit has been obtained by dealing with a small number of the vessels, and almost exclusively from import trade. The export trade and a great deal of the import trade have not come within the range of the operations of the Trust. By extending the accommodation either by jetties or wet-docks, and adding to the appliances already provided by the Trust, additional profit in working which is now absorbed by the intervening agencies employed for boating and handling cargo, will pass into the revenues of the Port Trust, and it will be possible to make further reductions, both in the charges against the ships and the charges on the goods. In fact, if the whole of the imports and exports of the port were discharged and loaded by the Port Trust, the charge to the consignees and exporters for doing the work could be materially reduced. Shippers would no longer incur the loss from peculation and damages from rough handling and exposure, and at the same time a surplus could be secured which would enable the Commissioners to take off some of the remaining charges now recovered from the shipping. Every advantage claimed for docks at Diamond Harbour would be equally secured by docks in Calcutta, and without putting merchants to the expense of providing new accommodation for the conduct of business, and entailing upon them the absolute loss of all that has already been done in Calcutta.

Mercantile objections to Diamond Harbour Docks.

64. The Committee cannot refrain from calling attention to the positive disadvantages which, in the opinion of those who are concerned in the actual business of the port, must result from any partial removal of the trade and the enforced dragging away of merchants, dealers, and their establishments from Calcutta to Diamond Harbour. It has been pointed out by the members of the Diamond Harbour Dock Committee who dissented from the general report, that in the opinion of one of the largest shipping houses, Messrs. Ralli Brothers, so far from "docks at Diamond Harbour proving an advantage, they would tend to cause many inconveniences both to importers and shippers." It was also pointed out that "an entire change will have to take place in the system of doing business before whole cargoes of grain, seeds, and other produce are bought up-country, assorted there by the shippers, and despatched right to the ship to be transferred at once from the railway wagons to the ship's hold." Of the seeds and wheat at present exported, 40 per cent. are not warehoused; but it should be noted that whatever quantity is exported direct from the Howrah railway station is subject to examination by shippers in the presence of the sellers, in order to ascertain condition, quality, weight, and refraction of the different parcels before shipment. Such operations could not be effected satisfactrily at Diamond Harbour unless at the geat expense of each shipper and seller keeping a separate establishment there.

Mutlah Canal.

65. The navigation of the river Hooghly, whether to Diamond Harbour or to Calcutta, must always remain an undertaking of some risk and danger, but whether the voyage terminates at the one place or the other, the Committee are satisfied that it would make no difference in the rates of insurance. If all the risks of the river are to be avoided, it can only be by a canal connecting Calcutta with the river Mutlah, and this is the alternative which the Committee would recommend. This project, which is referred to in paragraph 2 of the letter from the Government of India, Public Works Department, No. 116M., dated 14th March 1883, has received the careful consideration of the Committee, and all the works which have been recommended have been designed with a view to this canal being ultimately constructed. There seems to be a general conviction that whatever changes may occur in the Hooghly, there will always be a navigable channel leading through the Hooghly sands to the sea, but the changes that are constantly occurring entail considerable expense and constant watchfulness. The Mutlah offers a channel to the sea free of all obstructions, and if in connection with this channel there were a canal to Calcutta, capable of allowing the free ingress and egress of vessels of all sizes at all states of tide, there would then be a material and sufficient guarantee that works carried out at Calcutta for the accommodation of the shipping would always be utilised. There would be a direct gain in pilotage and time to the vessels using this channel, and a master could calculate with certainty on getting his vessel to sea at all states of the tide in one day. Vessels which now occupy two, and sometimes three, days in proceeding down the Hooghly, could almost invariably get to sea in 24 hours, and without incurring the risks to which they are liable from the shoals, freshes, and eddies of the Hooghly. The tides in the Mutlah are much easier than those in the Hooghly, and there are no freshets or eddies to contend with during the rainy season. The Port Commissioners have now asked Government to appoint them Conservators of the Mutlah, and to sanction a complete survey of the Mutlah River during the coming cold season. This will have to be done, and a careful survey of the banks made before any definite proposals for the construction of a canal can be submitted. But the following may be taken as a safe approximate estimate of the cost of the work.

Estimated cost of canal.

66. Assuming that the docks tne Committee have recommended at Kidderpore are carried out, no special works would be required at the Calcutta entrance. In fixing the depth of water over the sills at the Mutlah entrance, it has been borne in mind that as vessels could leave for sea from the Mutlah River at all states of the tide, the depth over the sills at the canal entrance must be sufficient to allow vessels drawing 26 feet of water to pass in and out of the canal at the lowest neap tides. The cost of the works at the Mutlah entrance may be taken at R25,00,000, and there would then only remain the cost of the land and the excavation of the canal. Assuming that the water in the canal is maintained at the same level as in the dock, or at the level of ordinary spring tides, *i.e.*, about 18 feet above datum, the excavation would only have to be carried to a depth of 12 feet below Kidderpore Dock sill. A considerable portion of the land that the canal would pass through is very low, most of it only 12 feet above datum. A section of the ground was taken by Mr. Taylor, Executive Engineer, in 1879, and from this section it has been calculated that the total amount of excavation would not exceed 488,550,000 cubic feet. The ground is almost level throughout, but rises slightly towards the Calcutta end. Approximate sections of the canal are given on plate.

Of the total quantity to be excavated, it has been assumed that 177,435,688 cubic feet will be taken out dry and the balance by dredgers. For the dry excavation R10 per 1,000 cubic feet would be an ample allowance, and for the dredged material R14 should cover every contingency. The total cost of excavation would therefore be—

	R
177,435,688 cubic feet, at R10 per 1,000	17,74,357
313,021,260 cubic feet at R14 per 1,000	43,82,298
Total	61,56,655

The land required for the canal and spoil-banks would be on the average 1,000 feet broad for the entire length of 29½ miles. This amounts to 12,885 bighas, which, at R50 per bigha, would cost R6,44,250. The spoil from the canal would all be deposited on the banks, and sufficient land has been provided in the estimate for this purpose. The cost of the canal, including land, would be approximately as follows:—

Mutlah Canal.

	R
Land	6,44,250
Excavation and dredging	61,56,655
Pitching	7,34,976
Damming Pialee River	50,000
Road bridge, Diamond Harbour Road	80,000
Bridges for Diamond Harbour Railway	80,000
Ferries	7,200
Inspection bungalows	20,000
Huts for subordinates	5,000
Offices at the Mutlah	25,000
Residence for Engineer, &c.	50,000
Entrances at Mutlah	25,00,000
	1,03,53,081
Contingencies	6,46,919
Total	1,10,00,000

Ways and means for construction of canal.

67. In paragraph 52 it has been shown that the annual surplus which may be expected on the completion of the docks now recommened would be R8,11,915, but this surplus would not all be available for the reduction of rates or to meet other charges, as R1,20,000 are now appropriated from jetty revenue to meet a portion of the expenditure incurred on the lighting and buoying of the channels of the Hooghly. After deducting this sum, there remains a balance of R6,91,915 which could be devoted towards meeting the charges on account of the canal to the Mutlah. The cost of that work has been estimated at R1,10,00,000, the interest on which, at 4½ per cent., would amount to R4,95,000. There would also be a charge for maintenance, repairs, pumping, dredging, which may be estimated at 2 per cent. on the cost, or, say, R2,20,000 per annum. The annual charges would therefore amount to—

	R
Interest	4,95,000
Maintenance, &c.	2,20,000
Total	7,15,000

Mutlah River to be lighted and buoyed.

68. Before the canal could be brought into general use, it would be necessary to light and buoy the Mutlah. The cost of buoying the Mutlah, so that it might be used by vessels during daylight, would be R72,560, and the annual cost of maintaining such buoys would be R8,990, as shown in the accompanying estimates. To light the channel, so that vessels could enter or leave the river at any time, would necessitate three light-vessels in addition to the present Mutlah light. The cost of three light-vessels would be about R5,00,000 and the yearly cost of maintenance about R30,000 each, or R90,000 annually for the three. The total cost of the lighting and buoying of the Mutlah would then be—

		R
Interest on R5,72,560	@ 4½ per cent.	=25,765
Depreciation and repairs @ 10 per cent. on capital outlay		=57,256
Maintenance of light-ships		=90,000
Total		1,73,021

Charges how to be met.

69. Adding this to the annual expenditure on account of the canal, makes the total charge for a second entrance to Calcutta *viâ* the Mutlah and canal, R8,88,021. There would be no necessity, therefore, to make any great increase in the present charges on the shipping for the additional facilities provided by this second entrance, as the profits on the work done in the docks would go a long way towards meeting all the charges; but it would of course be a question for consideration hereafter whether the whole cost of maintaining the canal and lighting and buoying the Mutlah should be met in this manner or by a direct charge on the vessels using this entrance. Every vessel using the Mutlah would save one-half of the amount now paid as pilotage on the Hooghly, and could consequently afford to pay canal dues if it should be determined to levy such a charge without incurring greater expenditure than is now involved in navigating the Hooghly. There would not be much gain by a small vessel of light draught using the Mutlah in preference to the Hooghly, but the Committee believe that if the canal were made, every large vessel would use it in preference to the Hooghly.

Capital required to be provided by Government.

70. It only remains for the Committee to consider how the funds for carrying out the proposed works are to be provided. The Government of India suggest for the consideration of the Committee "the expediency of the Port Commissioners carrying out the project by means of capital to be raised by them for the purpose;" but the Committee are of opinion that it would be impossible for the Commissioners to raise in the local market so large a loan on debentures as R2,00,00,000, and think they may fairly look to Government for assistance in this matter. In that view they would recommend that, in submitting the plans and estimates for the works for the approval of Government, an application should be made to Government to advance the necessary funds as required, charging interest at 4 per cent. to the capital account during the time the works are under construction, and upon their completion making the whole amount a permanent debt, bearing interest at 4½ per cent. It was in this way that funds necessary for the construction of the Prince's Dock in Bombay were raised, and Government should, the Committee are of opinion, come to the assistance of the trade of the port of Calcutta in a similar manner. There will be a direct gain to Government following from the construction of the docks in the matter of the effective control of the salt trade at a much less cost than is incurred at present, and in other indirect ways Government will share in the advantages which the works will confer upon the sea-borne trade generally. If Government will not meet the requirements of the port in the matter of ways and means as suggested, the Port Commissioners would have to ask for a Government guarantee to a special loan to be raised for the purpose of carrying out the works.

Summary.

71. The conclusions which have been finally arrived at, and the recommendations the Committee have felt justified in making after giving the fullest consideration to the several questions laid before them, many be briefly summarised as follows :—

(1) The accommodation for the trade of the port requires immediate extension, both for imports and exports, but especially for exports.

(2) The present jetty accommodation provides practically only for vessels bringing general cargoes, and for a very small portion of the export cargo taken by such vessels.

(3) The only manner in which *immediate* relief can be given to the export trade is by the extension of wharves for loading boats on the Howrah foreshore. The Port Commissioners should at once put in hand and complete the export wharf at Shalimar in time for the next grain-shipping season.

(4) There is room in the port for a considerable number of additional jetties, but the Committee do not recommend an extension of jetty accommodation, as they consider that for the general convenience of the whole trade of the port wet docks are preferable.

(5) The Committee recommend the immediate construction of wet docks at Kidderpore in accordance with the plans submitted herewith, and connected with the town jetties by a tramway along the river bank.

(6) The most suitable position for dock entrances is through the Government Dockyard at Kidderpore, and the Committee recommend the transfer of these premises to the Port Trust.

(7) The construction of the works recommended will be financially successful if the trade of the port is restricted to its present limits, and, in the event of further development of trade, will yield a large margin of profit.

(8) Docks at Howrah, especially for the export trade, are not recommended, because—

- (*a*) The Committee consider that the Calcutta side of the river is the most convenient in every way for the general trade of the port, and on completion of the railway bridge it will be quite as convenient for exports as the Howrah side.
- (*b*) The construction of two docks on separate sites would involve a larger outlay of capital, and entail on merchants and traders the maintenance of double establishments.
- (*c*) Docks at Howrah could not be brought into direct communication with the canal to the Mutlah.

(9) The railway bridge to connect the East Indian and Eastern Bengal Railways should be constructed at Cossipore.

(10) Docks at Diamond Harbour would neither be economical for the shipping nor convenient for the trade of the port.

(11) The docks at Kidderpore have been so designed as to admit of their connection by a canal with the Mutlah River, whenever the convenience or circumstances of the trade of the port may make its construction desirable.

(12) The survey of the Mutlah should be proceeded with at once, and on its completion detailed plans and estimates prepared for the ship canal.

(13) Government should assist the Port Trust in carrying out these works by either advancing the capital or guaranteeing the necessary loan.

HORACE A. COCKERELL,
Chairman.
WM. DUFF BRUCE.
J. J. J. KESWICK.
JAS. STEVENSON.
LORRAINE KING.
W. P. ALEXANDER.
H. B. H. TURNER.

NOTE.—Mr. Franklin Prestage proceeded on leave to England before the report was ready for signature.

G. H. SIMMONS,
Secretary.

PORT COMMISSIONERS' OFFICE;
CALCUTTA,
The 3rd September 1883.

A Summary of the Cost of the following Works proposed to be executed in connection with the Scheme for providing Wet Docks at Kidderpore.

			R	Total R
ESTIMATE	No.	1. Sixty-feet lock	18,84,444	
„	„	2. Eighty-feet entrance to tidal basin	8,78,324	
„	„	3. Tidal basin and 60-ton shears	12,66,051	
„	„	4. Double entrance from basin to Dock No. 1 . .	13,65.078	
„	„	5. Dock No. 1	71,22,064	
„	„	6. Boat canal	9,78,676	
„	„	7. Dock No. 2	88,35,468	2,23,30,105
„	„	8. Constructing boat wharves and extending the tramway to the proposed docks at Kidderpore . . .	7,44,000	7,44,000
				2,30,74,105
„	„	9. Graving Dock	8,70,293	8,70,293
		GRAND TOTAL	...	2,39,44,398

W. DUFF BRUCE, C.E.,
Vice-Chairman of the Port Commissioners.

KIDDERPORE DOCKS.

ESTIMATE No. 1.—*An Abstract of the Cost of Constructing the 60-feet Lock, complete with Gates, Jetty-heads, Sluices, Capstans, &c.*

	R
Excavation	85,439
Well-sinking	31,629
Cement brickwork in wells	78,713
Brickwork in lime mortar in wells	3,52,771
Do. do. walls	3,45,863
Do. cement-facing to walls	39,194
Granite quoins, &c.	1,08,024
Mirzapore stone quoins, coping, &c.	76,092
Metalling	1,380
Jetty-heads	2,05,776
Coffer dam across entrance	30,000
Gates	3,15,000
Sluice machines	21,000
Capstans	22,250
Total	17,13,131
Add for Establishment and Contingencies 10 per cent.	1,71,313
GRAND TOTAL	18,84,444

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 2.—*An Abstract of the Cost of Constructing the 80-feet Entrance to the Tidal Basin, complete with Gates, Jetty-heads, Sluices, Capstans, &c.*

	R
Excavation	38,406
Well-sinking	9,654
Brickwork in cement in wells	25,116
Do. lime mortar in do.	1,06,657
Do. do. in walls	1,33,661
Cement brickwork in facing walls	12,963
Granite quoins, &c.	36,944
Mirzapore stone quoins, coping, &c.	27,108
Metalling	360
Jetty-heads	2,17,208
Coffer dam across entrance	30,000
Eighty feet gate	1,40,000
Sluice machines for gate	8,800
Captsans	11,600
Total	7,98,477
Add for Establishment and Contingencies 10 per cent.	79,847
GRAND TOTAL	8,78,324

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 3.—*An Abstract of the Cost of Constructing the Tidal Basin, having an area of 9⅘ acres, and providing 60-ton Shears.*

	R
Basin walls	7,51,100
Excavation of basin	3,21,420
Metalling	2,436
Sixty-ton shears	70,000
Bollards	6,000
Total	11,50,956
Add for Establishment and Contingencies 10 per cent.	1,15,095
GRAND TOTAL	12,66,051

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 4.—*An Abstract of the Cost of Constructing the Double Entrance from the Tidal Basin to Dock No. 1, including Swing Bridge, Gates, Sluices, &c., complete.*

	R
Excavation	61,242
Well-sinking	20,823
Brickwork in cement in wells	59,282
Do. in mortar	4,73,509
Do. in cement facing to walls	30,920
Granite quoins, &c.	69,256
Mirzapore stone quoins, coping, &c.	56,948
Eighty-feet gates	1,40,000
Sixty-feet do.	1,05,000
Sluice machines for 60-feet gates	7,000
Ditto ditto 80-feet do.	8,800
Swing bridge over double entrance	1,50,000
Capstans	23,200
Timber dolphin	35,000
Total	12,40,980
Add for Establishment and Contingencies 10 per cent.	1,24,098
GRAND TOTAL	13,65,078

NOTE.—If a single 80-feet entrance is constructed instead of the above, a saving of R5,29,954 would be effected on the above estimate.

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 5.—*An Abstract of the Cost of Constructing Dock No. 1, having an area of 36½ acres, 6,550 lineal feet of Quay Space, 432,000 square feet of Sheds, complete with Cranes, Tramways, Fencing, &c.*

	R
Land	5,28,000
Dock walls	20,41,800
Excavation of basin	10,10,800
Cargo sheds	12,96,000
Dock offices	40,000
Quarters for Dock Master, Engineers, &c.	2,00,000
Out-offices for ditto	12,000
Engine-houses, chimney, accumulator towers	65,040
Hydraulic crane engines	2,00,000
Pumping engines for dock	2,00,000
Shed for coal, stores, and workshop	24,000
Culvert for water-supply	15,000
Hydraulic cranes	2,25,000
Pressure pipes	75,000
One-ton capstans	18,500
Tramways	1,78,500
Traversers	18,000
Crane lines	24,500
Drawbridge over boat lock	20,000
Metalling compound and gully-pits	1,15,464
Fencing	1,22,000
Electric lighting	25,000
Bollards	20,000
Total	64,74,604
Add for Establishment and Contingencies 10 per cent.	6,47,460
GRAND TOTAL	71,22,064

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 6.—*An Abstract of the Cost of Constructing the Boat Canal from the Docks to Tolly's Nullah, with three Road Bridges across the Canal.*

	R
Land	75,250
Excavation	4,09,538
Turfing	4,918
Boat lock	2,50,000
Three road bridges	1,50,000
Total	8,89,706
Add for Establishment and Contingencies 10 per cent.	88,970
GRAND TOTAL	9,78,676

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 7.—*An Abstract of the Cost of Constructing Dock No. 2, having an area of 64¾ acres and 10,630 lineal feet of Quay Space, 216,000 square feet of sheds, 126,000 square feet of Salt Golahs, complete with Cranes, Tramways, Fencing, &c.*

	R
Land	2,53,000
Dock wall	36,08,000
Excavation of basin	18,00,170
Cargo sheds	6,48,000
Salt golahs	4,41,000
Accumulator tower	5,000
Hydraulic cranes	1,50,000
Pressure pipes	75,000
Capstans	18,500
Tramways	4,63,750
Traversers	27,000
Drawbridge	1,60,000
Crane lines	45,500
Metalling	1,26,624
Fencing	1,60,700
Electric lighting	25,000
Bollards	25,000
Total	80,32,244
Add for Establishment and Contingencies 10 per cent.	8,03,224
GRAND TOTAL	88,35,468

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 8.—*An Abstract of the Cost of Constructing Boat Wharves from Chandpaul Ghât to the Outram Road, and from Prinsep's Ghât to the Government Dockyard; and extending the Tramway from the Jetties to the proposed Docks at Kidderpore.*

	R
Wharf from Chandpaul Ghât to Outram Road	34,000
Embankment from Outram Road to the Boat-house	44,000
Ditto Boat-house to the south side of Fort Point	1,50,000
Ditto Fort Point to Tolly's Nullah	1,79,000
Extension of Tramways from Jetties to proposed Dock	1,65,000
Lifting-bridge across Tolly's Nullah	1,05,000
Total	6,77,000
Add Contingencies	67,000
GRAND TOTAL	7,44,000

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 9.—*An Abstract of the Cost of Constructing a Graving Dock, 520 feet long, on the Blocks, with an Entrance 70 feet wide.*

	R
Excavation	51,008
Cement brickwork in wells	60,408
Brickwork in lime mortar in wells	2,09,778
Well-sinking	19,523
Brickwork in lime mortar in walls	1,10,785
Concrete	3,249
Cement brickwork facing to altars and walls	32,249
Metalling	1,916
Stone quoins, coping, &c.	60,900
Hand railing	280
Caisson	75,480
Bollards	4,000
Hydraulic capstans	11,600
Pumping engines, sluices, &c.	1,50,000
Total	7,91,176
Add Contingencies 10 per cent.	79,117
GRAND TOTAL	8,70,293

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 10.—*An Abstract of the Cost of Constructing a Ship Canal from the proposed Docks at Kidderpore to the Mutlah River.*

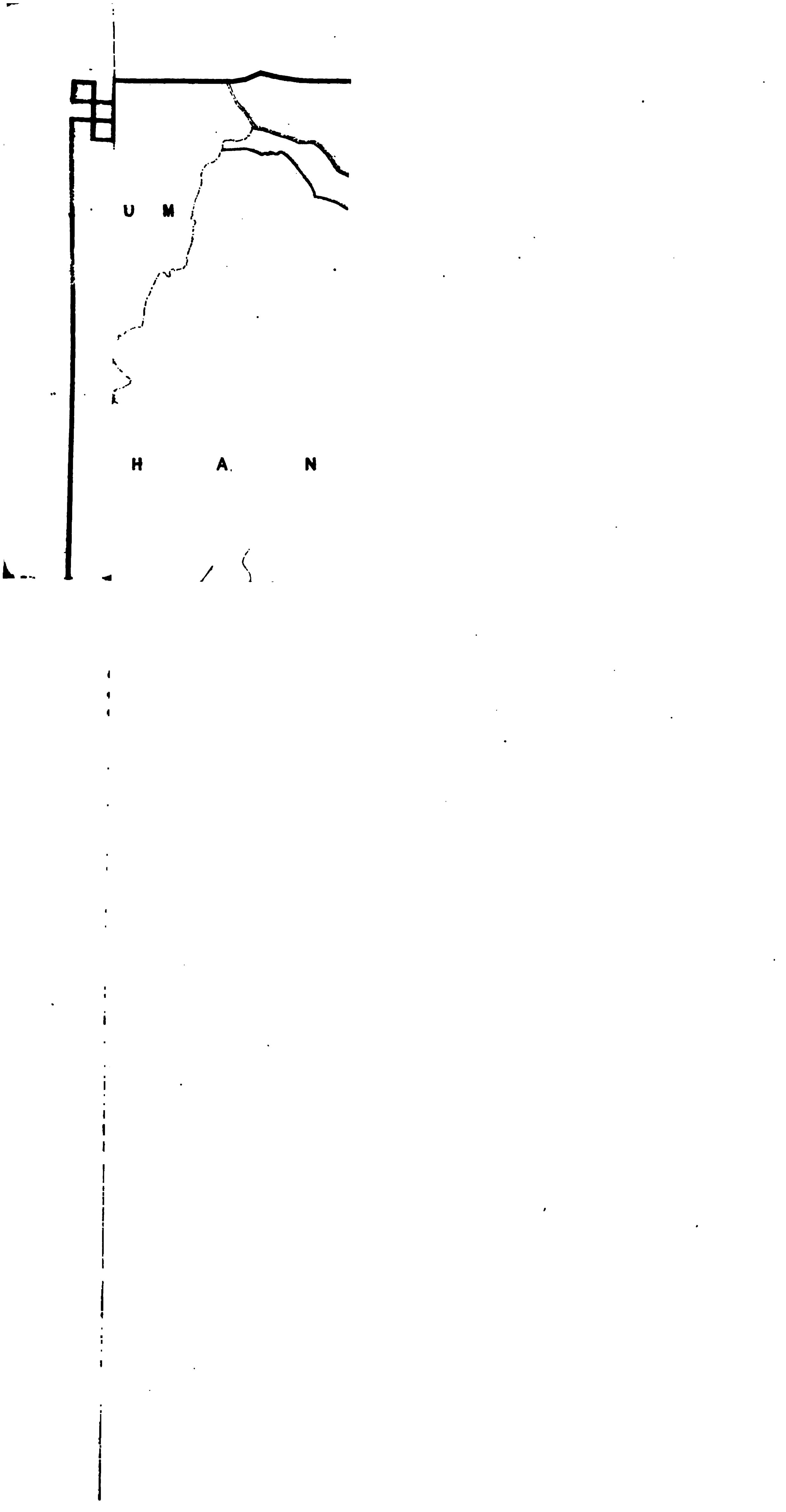
	R
Land	6,44,250
Excavation	17,74,357
Dredging	43,82,298
Stone-pitching	7,34,976
Damming the Pialee River	50,000
Double entrance between the basin and canal	12,20,000
Eighty-feet single entrance	5,50,000
Sixty-feet ditto	5,15,000
Jetty-heads	2,15,000
Road bridges	1,60,000
Ferries	7,200
Inspection bungalows	20,000
Huts for subordinates	5,000
Offices at the Mutlah	25,000
Residences at the Mutlah for employés	50,000
Contingencies	6,46,919
GRAND TOTAL	1,10,00,000

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE,
Vice-Chairman.

ESTIMATE No. 11.—*An Abstract of the Cost of Replacing the Mutlah River Buoys.*

	R
Two first-class wooden buoys	5,016
Nineteen second-class ditto	29,678
Twenty third-class ditto	18,920
Crossing-marks and sea-face beacons	4,000
Spare buoys	7,900
Spare chain	3,746
Spare moorings	3,300
Total	72,560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ESTIMATE No. 12.—*Light-vessels for the Mutlah.*

Regarding the lighting of the approaches to the Mutlah River, I have the honour to submit a chart of the entrance showing the number of light-vessels required, and the position that I consider they would be most advantageously placed in, to efficiently light the approaches to that river.

The two fine channels leading each side of the Rajmutlah Sand would of course be utilised,—the western channel for inward-bounders, and the eastern channel for outward-bounders.

Three light-vessels, besides the present Mutlah vessel, would therefore, in my opinion, be the minimum number required for the safe navigation of the entrance to the Mutlah.

There should never be any detention, either inward or outward, and with no pilots on the station I venture to say that with a good chart very few masters of vessels would hesitate to come right up and anchor under the lee of Haliday's Island. I estimate the cost of three new light-vessels, properly equipped and brought out to this counrry, at £45,000 for the three, and the up-keep out here of about R90,000 per annum.

E. W. PETLEY.

The 21st July 1883.

ESTIMATE No. 13.—*An Abstract of Cost of Maintaining the Buoys.*

	R
Two first-class buoys	300
Nineteen second-class do.	2,090
Twenty third-class do.	1,600
Annual repairs to do.	5,000
TOTAL . .	8,990

E. W. PETLEY,
Deputy Conservator, Port Approaches.

W. DUFF BRUCE,
Vice-Chairman.

From Lieut.-Col. J. M. HEYWOOD, R. E., Offg. Joint Secy. to the Govt. of Bengal, P. W. Dept., to the Secy. to the Govt. of India, P. W. Dept.,—No. 73 T—M P I, dated the 22nd October 1883.

I am directed, in continuation of the telegram dated 15th October, forwarded by His Honor the Lieutenant-Governor of Bengal to the Hon'ble T. C. Hope on the scheme for constructing docks in the Port of Calcutta, to submit a note drawn up in this Department, and to inform you that the Lieutenant-Governor accepts those conclusions, one to eight, of the Committee which are contained in the summary paragraph 71 of their report forwarded to you with letter No. 61T—M P I, dated 29th September 1883. The Lieutenant-Governor is willing to accept these recommendations very much in the desire to secure a final settlement of a large question which in the rapidly growing wants of the port is of great importance to Calcutta, and he feels himself in a measure bound to defer to the strong advocacy of the experienced Committee which have now reported on the subject, as well as to the unanimous protests of the mercantile community against any scheme which would take the docks away from the port of Calcutta. In the presence of the prevailing sentiment in Calcutta, no other project for wet docks than that which is now under consideration seems practicable. At the same time, without questioning the accuracy of the Committee's statements in favor of the Kidderpore scheme as at present contrasted with the establishment of docks at Diamond Harbour, His Honor cannot help feeling that the day may come when, owing to deterioration in the upper reaches of the river, the difficulties and cost of the Mutlah canal scheme, and the nearer proximity of Diamond Harbour to the sea, the present decision may be the subject of regret.

2. I am desired to add that, while the Lieutenant-Governor recommends for adoption the proposals of the Committee as specified above, he does not support any change in the site for the bridge across the Hooghly. This question was outside the scope of the Committee's enquiries, and on more than one occasion the Government of India have deprecated the re-opening of a matter which, after full deliberation, had been settled. To revive the discussion of

this question now would, in the Lieutenant-Governor's opinion, postpone the construction of the bridge for several years; and having regard to the fact that the operations for the commencement of the bridge are to be undertaken in November, and that all the extensive preliminaries for the work are completed, he would strongly deprecate any change now. On its merits he considers the advantages are in favor of the selected site; and in support of this view, he desires me to draw attention to a note by Mr. Bradford Leslie, attached for reference, in which the arguments for retaining the site as at present determined at Hooghly are fully set forth.

3. The surrender of the Kidderpore Docks, the taking over of the Port Commissioners' Docks at Howrah, as well as the larger question of the proposed loan to enable the Port Commissioners to carry out the Kidderpore project, are all matters for the Government of India to decide. The Lieutenant-Governor would only add that, in his opinion, the estimate of probable cost should be increased to 265 lakhs to cover charges for tools and plant, the interest on the capital sum expended while the works are in progress, the rise in the price of labor which generally follows the concentration of a large mass of labor in one spot, and to provide for contingent charges almost inseparable from a work of this magnitude when it is being carried out at great depths and in bad soil.

Note on the Kidderpore Dock Scheme by **Lieut.-Col. J. M. Heywood**, R. E., Officiating Chief Engineer, Government of Bengal, Public Works Department,—dated the 21st October 1883.

At present the operations of the Port Commissioners have been almost entirely restricted to import cargo brought from ports of the United Kingdom and the Continent of Europe. Occasionally a China steamer uses the jetties. Railway material intended to be despatched up-country from Howrah is delivered overside into boats. This, however, will be altered when the Hooghly Bridge is completed. No salt ships, nor the bulk of ships employed in the export trade, have hitherto been able to obtain jetty accommodation.

There is room in the port for the addition of 21 jetties on the Calcutta side of the river, and 20 jetties on the Howrah side. These 41 jetties would, it is estimated, cost 5 lakhs of rupees each, or 205 lakhs in all, and accommodate 1,066 vessels annually. The jetties which are in reality continuous wharves would cost almost as much as docks; while vessels lying at jetties have neither the security nor the conveniences which are afforded in a suitably arranged wet dock. The Committee propose to construct therefore docks, and prefer to do so at Kidderpore, with two entrances through the Government Dockyard premises. They recommend the transfer of the dockyard recently acquired by the Port Commissioners to the Government if it desires, or to the East Indian Railway Company if not required by Government, the work of Government being carried out in the Seebpore Workshops, except the docking of the pilot-brigs, and the few steamers alone remaining the property of Government now that the management and control of the port and the river survey buoying and light-vessels have been transferred to the Commissioners, which can be provided for in the proposed dockyard at Kidderpore.

The proposals started at different times for docks at Akra, Garden Reach, and Howrah, were examined and condemned. The first site was considered unsuitable on account of the eddies, which continue at all times of the tide, and only cease during the short interval between the tides (dead slack water), and the want of good anchorage ground. The Garden Reach site was more suitable, but the Committee consider the Kidderpore site better. A dock on the Howrah side was unanimously considered as unsuitable for the requirements of the port.

For the import trade there was no dispute that the dock must be on the Calcutta side.

The number of tons exported amounted in 1882-83 to 1,798,000, of which probably some—

	Tons.	
	607,000	were brought down by the East Indian Railway,
	278,000	by the Eastern Bengal Railway,
	823,000	by boats,
	90,000	by river steamers,
Total .	1,798,000	

with an excess on the side of the boat traffic, as a large number of boats escaped notice; so that 1,200,000 tons, or double the amount delivered on the Howrah side, are brought in on the Calcutta side, and the construction of the Hooghly Bridge will alter this proportion.

The only argument urged in favor of the Howrah side was that goods brought to the Calcutta side would incur a heavier charge for railway freight than goods delivered at dock in Howrah. This, however, it is ascertained, is not the case. "Calcutta and Howrah are for all practical purposes at the same distance from the export marts of the Upper Provinces."

The cost of the proposed site to the south of the Government dockyard will, according to the Committee, be comparatively inexpensive. The ground behind, as far as the Old Garden Reach Road, would cost about R1,500 per beegah. Beyond the Old Garden Reach Road for a distance of 1,000 feet, the land would be worth about R500 per beegah, and beyond that again a higher rate than R50 per beegah is not expected. The docks are to consist of an outer dock, and an inner, with entrance to the river through a tidal basin. From the tidal basin, which occupies an area of 9⅘ acres to the river, there will be two entrances, 80 and 60 feet; the 60-foot entrance being a lock 450 feet long, but with intermediate gates to take in vessels of less than 300 feet length and light draught. The tidal basin will communicate with the outer dock through a double entrance, with 60 and 80-foot openings. The outer dock will be 2,630 feet long and 600 feet broad, or about 36⅕ acres of area with 6,550 lineal feet of quay space, sufficient for the accommodation of 14 vessels. The inner dock will be 4,700 feet long and 600 feet broad, or 64¾ acres in area with a quay space of 10,630 lineal feet sufficient for 20 steamers and sailing vessels at the same time. In this dock a frontage of 2,200 feet will be set apart for the discharge of salt ships, and here large warehouses, specially designed for salt, will be provided, capable of accommodating 50,000 maunds with ample room for extension. Accommodation will also be provided in the docks for the coal trade and ballast ships, a quay space of 1,500 feet being appropriated for the purpose. The remainder of the quay space in the inner dock will be arranged for exports, with large sheds at each berth for the collection of cargo.

The Committee propose to fix the sill of the outer lock and the bottom of the tidal basin at a level of 14 feet below the level of the Kidderpore Dock sill, and that of the inner gates and dock 10 feet below the same datum. The depth of water in the main dock would be kept by pumping up to the level of the ordinary spring tides, *viz.*, 16 to 22 feet above datum, so that there would be a depth of 26 to 32 feet on the sills.

The outer lock and the tidal basin would nearly always have 26 feet of water, and during spring tides never less than 29 feet. During the rains this would be increased to 36 feet. The supply of water for the docks will be drawn from Tolly's Nullah, which, it is assumed, will be provided with locks, and improved as well as extended by Government, so as to bring the boat traffic, which now converges to Calcutta, into direct communication with the docks.

The Committee propose to connect Tolly's Nullah with the docks by a boat canal, the entrance being provided for by a lock 300 feet long and 40 feet wide.

The docks will be connected with the jetties and inland vessel wharves by an extension of the Commissioners' tramway along the riverside from Chandpal Ghât to Kidderpore. To obtain room for a double line of rails it will be necessary to construct a retaining wall about half tide level outside the present Strand Road. Wharves for inland vessels will be provided from Chandpal Ghât to the north end of the carriage stand at the Eden Gardens, and from Prinsep's Ghât to Tolly's Nullah.

The estimated cost of these works is as follows:—

	R
Entrances to tidal basin	27,62,768
Tidal basin (9⅘ acres)	12,66,051
Entrance from basin to dock No. 1	13,65,078
Dock No. 1 (36⅕ acres)	71,22,064
Dock No. 2 (64¾ acres)	88,35,468
Boat canal	9,78,676
Boat wharves and tramway	7,44,000
	2,30,74,105
Add for a graving dock (520 feet)	8,70,293
GRAND TOTAL . . .	2,39,44,398

The income to be expected is calculated out thus—

From Imports.

Ships entering the port in 1882-83 not berthed at jetties.			Probable number which would use the dock.		Income expected on imports.		
Number.	Nature of cargo.	Tonnage.	Number.	Tonnage.		Landing rate per ton.	
					Similar to jetty hire. ⎫ 4½ annas " " mooring hire. ⎭ per ton. 173 vessels, averaging 1,375 tons—R66,912.	R a. p.	R
33	Iron . .	72,617	33	72,617		1 0 0	72,617
40	Coal . .	75,513	24	45,513		0 10 0	28,445
174	Salt . .	326,555	116	200,000		1 0 0	2,00,000
						Dock charges	66,912
247	......	474,685	173	318,130		...	3,67,974

this question now would, in the Lieutenant-
bridge for several years; and having regar
of the bridge are to be undertaken in No
work are completed, he would strongl
the advantages are in favor of the s
draw attention to a note by Mr. B
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3. The surrender of th
Docks at Howrah, as well as
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Vessels bringing coal for
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44,

Diminished by $\frac{1}{10}$ =403

Note on the

At vessels which only enter the dock to load will be ⅔rds of the full rate
to im or R91,215.
Occ ping charge to be added at the rate of R1 per ton is calculated on all the cargo
c to Europe, Africa, America, and Australia. All shipments for Indian ports, China, Burmah, or Ceylon are omitted. A deduction of 10 per cent. is made to meet the case of vessels continuing to load in the river.

	R
The result is 1,191,734 tons, at R1 per ton	11,91,734
Total for exports .	12,82,949
Add for imports	3,67,974
„ for rent of lands	1,20,000
„ for wharfage from boat dock	75,000
Total .	18,45,923

Against this must be set—.

Working expenses	7,38,397
4½ per cent. interest on a capital debt of R2,30,74,105 . .	10,38,335
	17,76,732

	R
Surplus .	69,191

To this may be added the surplus receipts at the jetties according to the actuals in 1882-83, *viz.*, R1,21,800, and the surplus becomes R1,90,991. This financial result is obtained by assuming the trade of the port to be that actually experienced in 1882-83, but the Port Commissioners show that since 1878-79 the number of vessels, steamers, and sailing ships has increased from 967 to 1,151, the gross tonnage from 1,430,789 to 1,982,187, and the net tonnage from 1,115,392 to 1,510,344, *viz.*,—

19 per cent. in number of ships,
38 „ gross tonnage,
35 „ net „

the increase having been most rapid in the last two years of the series, while the returns of the present year show that the trade is still increasing.

The Committee fully expect that the 576 vessels—

173 loading and discharging,
403 „ only,

shown as the probable number which will resort to the docks, will have increased when these are finished to 864, the full number which can be accommodated.

The additional income is estimated—

		R
For 289 additional vessels (including one to be accommodated at the jetties) at		8,68,734
Deduct additional cost		2,47,800
	Balance	6,20,934
Add surplus shown above		1,90,991
	Total	8,11,925

The Committee, in addition to the question of the docks and the arrangements necessary in connection with them, discuss certain additional facilities proposed at Howrah for accommodating the export trade, the position of the railway bridge across the Hooghly, the accuracy of the data on which the financial results of the Diamond Harbour scheme were based, and the cost of constructing a canal connecting the Mutlah with the proposed Kidderpore Docks.

At Howrah the increased accommodation now being provided by the Railway Company, together with the extensions which can be carried out on the Port Commissioners' wharves at Howrah between the railway premises and Shalimar, and, if necessary, extensions hereafter below the Botanical Gardens at Garden Reach, will, it is hoped, suffice to meet the requirements of the export trade which concentrates at Howrah until the wet docks are ready for use. The Committee consider the position of the Hooghly Bridge would entail great inconvenience, and are of opinion that no scheme of port improvement can be complete without a railway bridge as close to Calcutta as possible, connecting the docks and railways on the east and west banks of the river.

In view of the proper working of the port, they therefore propose that the bridge shall be constructed at Cossipore. They urge that in the event of any extensions of railways to the south and west of Howrah, the trade will be cut off from the conveniences of the proposed docks, except by making a detour of about 42 miles to cross by the bridge at Hooghly, and that the site of that bridge is not far enough north to give the greatest benefit to the trade with Eastern Bengal. For this latter purpose they give the preference to a site at Kulnah.

The Committee in scrutinizing the data put forward by the Committee appointed to consider the question of constructing the wet docks at Diamond Harbour dispute their accuracy, and assert that the pecuniary advantages claimed for that scheme disappear.

These advantages were according to the last-mentioned Committee—

1st.—Vessels would escape the dangerous and intricate navigation of the upper reaches of the Hooghly between Calcutta and Diamond Harbour.

2nd.—A saving of time, coal, pilotage and towage would be effected, the money value of which alone would be sufficient to cover the dues payable for the use of the docks.

3rd.—The docks can be constructed and maintained at much less cost than docks constructed at Calcutta.

As regards the first advantage claimed, it is assumed that though there may be extensive and sudden changes in the Hooghly, entailing considerable expense and constant watchfulness, there will always be a navigable channel leading through the Hooghly sands to the sea, and it is argued that unless there is a very important reduction in the charges against vessels docked at Diamond Harbour, as long as vessels can get to Calcutta, there will be no object in their stopping short.

The charges, as calculated out by the Diamond Harbour Committee, are given in paragraphs 42 to 45 of their report. The Committee first note that the saving on towage, instead of being, for the steamer, R411, would only be R270-12, according to the sanctioned schedule of pilotage charges, and in the case of the sailing ship, R226-8, instead of R378, and then go on to point out that no charge for port dues is entered for vessels navigating the Hooghly and stopping at Diamond Harbour, whereas the port dues which are levied for the keeping up of lighting, surveying, and buoying the Sand Heads and channels of the Hooghly should be in reality 6 annas per ton, *viz.*,—

4 annas port dues,
2 „ extra for pilotage,

the present charge in the Port of Calcutta, *viz.*, 1 anna per ton, having been reduced to that figure owing to the contribution made by the Port Commissioners from the general revenues. This would necessarily not be available in the case of ships not contributing to the revenue of the Port Trust.

They consider that the dock dues entered at 14½ annas should be increased to R1-9-6 per ton, and that the cost of carriyng goods to and from Calcutta would be R1 per ton, so that the total cost of landing the cargo at Calcutta, when goods are warehoused there, would be R2-9-6 per ton.

They compare this with R1-4-6, the proposed charge in the Kidderpore Dock scheme, and come to the conclusion that the actual difference between landing and shipping goods in Calcutta and at Diamond Harbour would be (R2-9-6 less R1-4-6) or R1-5-0 less at the former place.

The advantage claimed in a pecuniary point of view by the Diamond Harbour Committee is still further reduced when the comparison is made with vessels entering docks at Calcutta. In fact, the Committee consider that the pecuniary advantages claimed for the Diamond Harbour project disappear, the money resources and establishment at the disposal of the port allowing of reductions in the charges which would be impossible at Diamond Harbour, and this combined with the cost of the land carriage turns the scale, while they anticipate very large additional profits will ensue when the handling of the cargo, owing to the extension of the port accommodation, falls more completely into their hands, and this without putting the merchants to the trouble of the removal of their establishments or the expense of providing additional establishments and of building new accommodation for the conduct of their business away from Calcutta.

On the subject of connecting the Mutlah with the proposed docks in Calcutta, the Committee have prepared a rough estimate, amounting to R1,10,00,000, and recommend that a complete survey of the Mutlah River shall be undertaken during the coming cold season. They estimate that the annual surplus of the port, after the completion of the docks recommended being R8,11,915 less R1,20,000 appropriated for lighting and buoying the channels of the Hooghly, or R6,91,915, there would be no necessity to make any great increase in the present charges to meet the annual expenditure on account of the canal as detailed below:—

R	
4,95,000	the interest at 4½ per cent. on R1,10,00,000.
2,20,000	the charges for maintenance, repairs, pumping, and dredging.
25,765	the interest at 4½ per cent. on the original cost of buoying the Mutlah and providing lightships.
57,256	depreciation and repairs at 10 per cent. on capital outlay.
90,000	maintenance of lightships.
8,88,021	

The canal would be 75 feet at the base with side slopes of 2 to 1, a depth of 30 feet, and a length of 29½ miles.

It is admitted on all hands that increased facilities are required for the trade of Calcutta, and the representatives of the mercantile community of Calcutta have, in the report under consideration, accepted the risk of navigating the upper part of the Hooghly between Diamond Harbour and Calcutta, rather than remove their business to a point at a distance from Calcutta. This admitted, it does not appear that any argument can be urged in favour of the Diamond Harbour scheme on the ground that docks there could be more cheaply constructed than at Calcutta.

The differences between the designs submitted to Government consist in the following:—

At Kidderpore the entrance to the tidal basin will be through a lock 450 feet long and 80 feet broad, with intermediate gates to take in vessels of less than 300 feet length and light draught, or through a passage of 60 feet in width. At Diamond Harbour the entrances would be by two locks—one 560 by 80, the other 400 by 60.

The tidal basins in the two schemes are 600 by 650 feet and 800 by 800 feet.

The entrances from the tidal basin into the docks are in each case 60 and 80 feet wide, but the Kidderpore Docks are to be double. One 2,630 feet long and 600 feet broad, or 36¼ acres in extent, the other 4,700 feet long and 600 feet broad, or 64¾ acres, capable of accommodating respectively 14 and 20 vessels.

The Diamond Harbour Docks are designed 4,000 feet long and 500 feet broad, or 46 acres in extent, suitable for 18 vessels.

The total cost of the Kidderpore Docks, including all charges, is, as mentioned in a previous paragraph, estimated at about 239½ lakhs. Omitting from this the cost of the boat canal, boat wharves, and graving dock, and adding the large sum represented by 10 per cent. to the estimate as a precaution should the establishment and contingent charges prove greater than expected, the cost would become about 235 lakhs with provision for 864 ships.

The cost of the Diamond Harbour Dock is estimated at 178½ lakhs—

	140	lakhs, the estimate by the Special Engineer,
	10	lakhs, added by the Committee for establishment during construction,
	28½	lakhs, for furnishing the whole dock with godowns, tramways, and hydraulic cranes,
Total .	178½	lakhs,

the provision being for 468 vessels.

To bring the comparison as close as possible, the greater part of the cost of the smaller dock in the former scheme, amounting, with the addition of 10 per cent., to 69¼ lakhs, should be excluded, leaving the accommodation still rather larger, and the cost 165¾ lakhs against 178½ lakhs, the estimate for the Diamond Harbour Dock. A scrutiny of the rates of the Kidderpore Dock scheme shows that on the whole they may be accepted if work is pushed on rapidly; but the establishment and contingent charges being calculated together at 10 per cent. are fixed too low to be safe, particularly as there must be an uncertainty about the amount of unwatering which may be necessary. It is understood that specific sums for pumping have been omitted, as the powerful pumping engines required for the working of the graving dock will be set up at an early stage and used for drying out the foundation pits of the locks and docks, but working at the depths contemplated and in soil of the kind found during the borings is attended with uncertainties, and the cost of pumping may exceed present anticipations. The charge for tools and plant omitted from the estimates, together with the interest on the capital sum expended while the works are in progress, and the probable rise in the price of labour caused by its concentration in one spot where some 40 or 50 lakhs of expenditure will be incurred in the year, all justify the increase of 10 per cent. on the original estimates of the Kidderpore Dock scheme.

It is unfortunate that the absence of complete rates and details in the estimates for the Diamond Harbour Dock prevents a closer comparison than that made above; but it is nearly certain they are not under-estimated, as the soil in parts of the ground to be occupied by the work was found to be very bad. A well in course of sinking, when the Committee submitted their report, having reached, at a depth of 25 feet out of some 40 feet, the level of the bottom of the dock wall—a stratum of watery sand which appeared to be little better than a quicksand. This led the Engineer to remark that the condition of affairs disclosed by the borings and well, should it prove to be alike over any considerable portion of the area, introduces an element of uncertainty as to the cost of at least one part of the contemplated work. Those rates which are given exactly agree with the ones selected for the Kidderpore scheme, *viz.*—

Excavation, including transport with an addition of 25 per cent. for pumping	R 20	per	1,000 c. ft.
Ordinary brickwork	„ 36	„	100 „
Brickwork in cement	„ 50	„	100 „

The estimates for the expenditure to work the docks in the two schemes are given so differently that it is impossible to compare them.

The amount shown in the Diamond Harbour Dock report is R1,95,000 per annum for 468 vessels, but this omits the cost of establishment for supervising the discharge of the vessels, tallying and sorting cargo in the sheds, as well as the coolie labour and the interest on the cranes, sheds, and tramways. In the Kidderpore Dock report the estimate for expenditure reaches R7,38,397 for 576 vessels—a sum which includes all the items omitted as detailed above.

It appears, moreover, that rates for skilled labour are, as might have been expected, higher at Diamond Harbour than at Calcutta, and it is reasonable to suppose that establishment charges must be considerably less at the latter place where an establishment for control, engineering, and supervision already exists.

There are other aspects of the question which must be considered.

The land at Diamond Harbour is more subject to storm-waves; there is no fresh water for drinking; the docks would be open to attacks in time of war, and there is much exposure to the south-west monsoon.

The returns expected, should the dock be built at Kidderpore, have been prepared by a very competent body of men, and it seems an acceptable estimate that, out of 1,151 vessels entering the port (the number of arrivals in 1882-83), 775 should use the jetties and docks, *viz.*—

372 to load and discharge,
403 to load only,
———
775
———

nor does it appear extravagant to assume that the trade which is rapidly increasing will receive a fresh impetus as the numerous railways under construction or contemplated are finished. The probable diversion of the whole of the Punjab and North-Western trade above Delhi, and the partial diversion of the trade below Delhi to Cawnpore, being more than replaced by the accession of traffic from new sources.

The improvements effected or in hand on the Howrah side of the river for increasing the accommodation and facilitating the prompt delivery of the upward and downward goods are detailed in Colonel deBourbel's note of the 16th June last. He lays down that a shed capacity in all of 18,000 tons, with a daily delivery which may reach 8,000 tons, should be provided at the Howrah terminus. Of this, from improvements in progress, there will be provided a gross capacity of goods sheds for 1,600 tons outward and 9,200 tons inward merchandise traffic, with a daily delivery under the rule of 24 hours for removal, amounting to 5,800 tons, *viz.*, 1,000 tons upwards and 4,800 tons downwards, the latter of which with other means of temporary relief now afforded may reach 5,400 tons. An estimate has also been received from the Port Commissioners amounting to R4,01,591, which provides for constructing a new boat wharf at Shalimar Point, laying down tramway lines from the Howrah Terminus of the East Indian Railway to Shalimar Point along the river foreshore, and building three landing-stages for the boat wharves.

The position for the Hooghly Bridge is one on which much difference of opinion exists.

The arguments against the site fixed upon, after much careful consideration by Government, are given in a former paragraph.

These may be recapitulated—

1st.—The bridge will be too far above Calcutta to assist in the working of the port, and will not be far enough north to give the greatest benefit to the trade with Eastern Bengal.

2nd.—The possible convergence of railways to Howrah from the south and west districts demands a direct passage into Calcutta.

3rd.—A large expense will fall on the Railway Companies to allow of the conveyance of goods brought across the bridge, a double line being required from Naihatti to Kidderpore, with station accommodation on the Calcutta side.

The arguments in favour of the Hooghly Bridge site are—

1st.—The most important line projected to tap the districts south of the East Indian Railway will be most economically brought into Calcutta *viâ* Seetarampore, and would be accommodated by the erection of the bridge at Hooghly.

2nd.—The traffic at Howrah will not diminish as long as the Hooghly continues navigable to Calcutta. It will be cheaper for free vessels to load export produce while lying at moorings in the stream.

3rd.—Local goods traffic between Howrah and Calcutta will not cross by the Cossipore Bridge.

4th.—The width of the river at Cossipore is double that at Hooghly, and as the width cannot be contracted, the bridge will cost double the amount it will cost at Hooghly. The junction railway would pass through more valuable land at the Cossipore site, and a bridge could not be completed there till 1888. The alteration in site would entail a loss of 5 lakhs of rupees, irrecoverable if the works at Hooghly were abandoned.

5th.—The cost of the junction railway between Hooghly and Naihatti (4⅔ miles) would be 48½ lakhs; whereas if the Cossipore site is preferred, the junction railway (4¾ miles) would entail an expenditure of 76 lakhs, and an addition of 42 lakhs for the Mymaree, Kulnah, and Rangaghat junction.

6th.—The factories above Cossipore now on the banks of the river, and which it is assumed will largely extend, will be better served by the Hooghly Bridge. The importance of these factories is proved by their using 123,000 tons of coal, taking in some 231,000 tons of raw material and outturning 200,000 tons of finished material.

7th.—The Mymaree-Ranaghat Railway would only be the direct route for coal for the Northern Bengal, upper portion of the Eastern Bengal, and Ranakhat-Bongong Section of the Central Bengal Railway, amounting to not more than 25,000 tons of coal annually. From Dacca eastwards coal will probably come from Assam.

8th.—The doubling of the Eastern Bengal Railway below Kanchraparah is necessary under any circumstances, and should not therefore be debited as an addition to the cost of the junction *viâ* Hooghly.

The Committee's estimate of the cost of the Mutlah Canal, R1,10,00,000, is one which it is not easy to criticise very closely, and the estimate submitted is only approximate, the definite proposals being postponed till a complete survey of the Mutlah River, contemplated during the ensuing cold weather (1883-84), has been carried out; but if we once recognize the possibility of the channels of the Hooghly deteriorating, thereby becoming impassable for steamers of large burthen and great draught, and admit that the same causes which may lead to deterioration in the Hooghly above Diamond Harbour will affect the reaches below in which some of the worst and most shifting channels are to be found, it follows that the feasibility of opening out an alternative route from the sea to the port of Calcutta becomes of great importance, more particularly as, granted its construction at any cost other than prohibitive, a guarantee is afforded that the expenditure on works in Calcutta will not be ultimately thrown away.

As at present, however, there is nothing to show that the Hooghly is deteriorating, the scheme of the Mutlah Canal can be worked up at leisure.

To sum up—The question of affording increased facilities to the trade of Calcutta is narrowed down to the provision of docks at Calcutta or at Diamond Harbour.

The merchants decline to entertain the idea of transferring their business to a point away from Calcutta as long as ships can find their way up to that port, preferring to accept the risks of the navigation.

There is no reason to believe that the Hooghly is deteriorating, and the estimates show that the balance of advantages as regards cost of first construction and subsequent maintenance remains on the side of work carried out in Calcutta, the resources and establishment of the port being available.

If the Hooghly deteriorates, the effect would be experienced in the lower as well as the upper reaches, and should the large vessels, now employed in the trade, not be able to reach Calcutta, it will be feasible to open up a passage by water to the Mutlah.

The position of the docks in Calcutta has been determined after careful consideration and the project worked out with care and skill; but for reasons given previously, the estimates should be increased to 265 lakhs.

The arrangements to connect the docks with the water-system and railways on the left bank of the river are suitable.

The arguments in favor of the construction of a permanent bridge as near Calcutta as possible to connect the two sides of the river are of great force. The expenditure, however, already incurred on the Hooghly Bridge, the great delay which would be experienced by introducing any alteration now, as well as the large increased cost which would be entailed by the construction of a bridge near Calcutta, though this must be faced sooner or later, are considerations to be weighed.

J. M. HEYWOOD.

From the Government of India, to the Secretary of State for India,—No. 57, dated 30th October 1883.

We have the honour to address your Lordship on the important question of providing additional facilities for the rapidly increasing export and import trade of the port of Calcutta.

2. The appointment of a Committee to consider the question of the construction of wet docks at Diamond Harbour was approved in Lord Hartington's Despatch No. 119R., dated 31st August 1881. In February last we received from the Government of Bengal the report of the Committee, together with a Minute by His Honor the Lieutenant-Governor and other papers, the whole of which are appended to this despatch.

3. The Committee was composed as shown in the margin. The official members and Mr. Bradford Leslie held that the construction of docks at or near Diamond Harbour was desirable on the whole, notwithstanding various objections and difficulties which were feely admitted. The three mercantile members, on the other hand, strongly opposed the scheme, on grounds varying in detail, but which may be broadly stated as combining doubts regarding the suitability of Diamond Harbour as a port, with a strong reluctance to incur the heavy original sacrifice of invested capital, and the subsequent inconvenience and current expense involved in transferring business to another locality until the capabilities for extension of the port of Calcutta itself had been exhausted. In this objection to a transfer it soon became apparent that they had the support of the mercantile community in general.

PRESIDENT:

Hon'ble A. J. Reynolds, C.S., Chairman of the Port Commissioners.

MEMBERS:

H. C. Levinge, Esq., C.E., Secretary to the Government of Bengal, Public Works Department.

Colonel S. T. Trevor, R.E., Joint Secretary to the Government of Bengal, Public Works Department.

Bradford Leslie, Esq., Agent, East Indian Railway.

R. Steel, Esq. (Messrs. R. Steel & Co.).

G. H. Morrison, Esq. (Messrs. Turner, Morrison & Co.).

C. W. Wawn, Esq., C.E., Special Engineer to the Committee.

J. J. J. Keswick, Esq. (Messrs. Jardine, Skinner & Co.), appointed on the departure of Mr. Steel.

4. His Honor the Lieutenant-Governor consequently decided in March last that, before taking action on the proposals of the majority of the Committee, the question of the measures which it was possible to take for the extension of the existing accommodation of the port of Calcutta, and the cost of any changes deemed to be desirable, should be fully and closely investigated by the Port Commissioners, in communication with the Bengal Chamber of

Commerce. In approving of this course, we suggested that the enquiry should embrace the feasibility and cost of a wet dock of reasonable size, but capable of enlargement hereafter, and the expediency of the Port Commissioners themselves carrying out the project by means of capital to be raised by them for the purpose.

5. A joint Committee was consequently appointed by the Port Commissioners and the Chamber of Commerce, consisting of eight members, who are named in the margin. The report of this Committee has been formally and unanimously adopted by the Port Commissioners and the Chamber of Commerce, and is forwarded, together with the opinion of the Bengal Government thereon, as an enclosure to this despatch.

Appointed by Port Commissioners.
H. A. Cockerell, Esq., C.S., C.S.I., Officiating Chairman, Port Commissioners.
D. Scott, Esq., C.E., Officiating Vice-Chairman, eventually relieved by W. Duff Bruce, Esq., Vice-Chairman.
Franklin Prestage, Esq., C.E., Agent, Eastern Bengal Railway, and on his departure,—Bradford Leslie, Esq., Agent, East Indian Railway.
W. P. Alexander, Esq. (Messrs. Mackinnon, Mackenzie & Co.).
J. J. J. Keswick, Esq. (Messrs. Jardine, Skinner & Co.).

Appointed by Chamber of Commerce.
Hon. R. Miller, President of the Chamber, and on his departure for England,—Lorraine King, Esq. (Messrs. Vale, King & Co.).
James Stevenson, Esq. (Messrs. Graham & Co.).
H. B. H. Turner, Esq. (Messrs. Turner, Morrison & Co.).

6. The conclusions arrived at unanimously by the Committee are given in their 71st paragraph, and the principal ones may be summarised as follows:—

(*a*) That docks at Diamond Harbour would neither be economical for the shipping nor convenient for the trade of the port.

(*b*) That increased accommodation is most urgently needed, to meet the requirements of the import and export trade, especially the latter, and that the port of Calcutta is capable of all the extension now or hereafter required.

(*c*) That wet docks are a mode of extension preferable to jetties, considering the general convenience of the whole trade.

(*d*) That the Calcutta side of the river is the more convenient in every way for the general trade, and that Kidderpore is the best site for wet docks, the entrances to which should pass through the Government Dockyard there.

(*e*) That the docks at Kidderpore should be so designed as to admit of their connection by a ship canal with the Mutlah River, whenever the convenience or circumstances of the trade of the port may make its construction desirable.

(*f*) That the docks will be financially successful, even if the trade of the port is restricted to its present limits; and that, in the event of further development of trade they will yield a large margin of profit.

(*g*) That Government should assist the Port Trust in carrying out the works proposed, by either advancing the capital or guaranteeing the necessary loan.

(*h*) That the only way in which *immediate* relief can be given to the export trade is by the extension of wharves on the Howrah foreshore for the loading of boats.

We will now proceed to offer some remarks upon these conclusions.

Diamond Harbour scheme.

7. The project of constructing docks at Diamond Harbour is of very old date, having been reported on by Captain Boileau in 1839. In the years 1844 to 1847 a thorough investigation of the means of improving the trade facilities of Calcutta took place. A Committee, of which Lieutenant-Colonel Forbes, R.E., was President, reported in May 1846 in favour of wet docks at Kidderpore, while in 1847 Mr. F. W. Simms, C.E., Director of the Railway Department, examined very fully the proposals of a "Calcutta and Diamond Harbour Dock and Railway Company," coming to the conclusion, as between Diamond Harbour and Kidderpore, that one site possessed no great advantage over the other. Lord Dalhousie, however, in a Minute, dated 20th April 1853, emphatically condemned the project of railway communication with Diamond Harbour in the following passage:—

> "27. The only local line which is at present contemplated within the Presidency of Bengal is the line from Calcutta to Diamond Harbour. The object which it is intended to secure by the construction of this line is indicated in the first paragraph of the despatch from the Honourable Court. The despatch observes : 'Adverting to the difficulties and dangers which attend the navigation of the river between Calcutta and its mouths, it appears to us that these evils would in a great measure, if not altogether, be avoided by means of railway communication, and that such a work would, in other respects, be productive of much public benefit, and would materially promote the shipping and mercantile interests connected with your Presidency.'
>
> "In order to enable this Government to give an opinion as to the dangers incurred by trade and shipping in the navigation of the Hooghly, and as to the sufficiency of a railway to Diamond Harbour as a remedy for the evils adverted to, I caused a reference to be made to the Superintendent of Marine.

"That officer has submitted a return showing all the vessels that have been lost in the navigation of the Hooghly during the last 20 years. They amount to 51 in number. Of these, only 9 were lost above Diamond Harbour, all of which were weak and inferior ships. It further appears that among such ships as have taken the now common precaution of being towed by a tug-steamer, only one has ever been lost below Diamond Harbour, and not a single one above it.

"These facts, briefly stated, afford the means of effectually testing the value of the present project.

"They show that a railway to Diamond Harbour, far from averting 'in a great measure, if not altogether, the dangers of the navigation of the Hooghly, would exercise a very small influence over them, for they lie chiefly below Diamond Harbour. They further show that, whenever ships have recourse to the usual easy and accessible precaution of steam towage, the dangers of the navigation are reduced to nothing above Diamond Harbour, and as nearly as possible to nothing below it.

"Apprehensions have been entertained that the navigation of the river might be closed altogether by the silting up of the channels near the James and Mary Sand. No information has ever been before me to show that this is a probable event, or that it has of late years become more probable. Until it does actually occur, or until the probability thereof becomes imminent, or until those huge arks which have been spoken of and to which Captain Rogers alludes, shall really be the vehicles for the commerce of India, I am unable to advise the construction of a railway from Calcutta to Diamond Harbour.

"Fleets of magnificent merchant ships annually come and go uninjured, and even unimpeded. The fine steam-ships of the Peninsular and Oriental Company habitually run up and down the river safely and at a very high rate of speed. The large mail steamers of the Screw Company, and the heavily-armed steam frigates of the Indian Navy, perpetually traverse the channel without difficulty or danger.

"I do not believe that the formation of a railway to Diamond Harbour would be of the slightest benefit to any one of these, or that, if it were opened for traffic to-morrow, it would induce any one of them to anchor there, or to depart from their usual plan of proceeding direct to this city, with the advantages of proximity to their cargo and agents, of accessibility to their passengers, and manifold other conveniences, both for those who belong to the ships and for those ashore.

"I am aware of no benefit whatever which would be derived by the Government from the existence of such a line of railway; nor is it apparent to me in what other respects it would be productive of benefit to the shipping and mercantile interests of this Presidency.

"If, however, those interested are of opinion that a railway to Diamond Harbour would be advantageous to them, I respectfully submit that the proper course is that their own enterprise should provide the line for their own advantage. It would be a line of limited extent, of very easy construction,—for there does not appear to be any formidable engineering difficulty in its course,—and cheap, excepting where it would be necessary to purchase land in the immediate vicinity of Calcutta. The project, therefore, would be easily accomplished by a very small exertion of enterprise, and a comparatively small amount of capital.

"As the dangers of the navigation do not loudly call for this line, as the interests of the Government would in no respect be promoted by it, and as it is quite within the ordinary compass of joint-stock undertakings, I beg leave to express very strongly my opinion that it should not be taken in hand by the Government of India, and that, if private parties should engage in it, the Honourable Court should not come under the obligation of guaranteeing interest upon the capital raised for it in any amount whatever."

The Diamond Harbour scheme was not, we believe, revived till 1881, but in the intervening years various projects were brought forward for wet docks in the suburbs of Calcutta, *viz.*, at Howrah, at the Botanical Gardens, at Chitpore, at Sealdah, at Kidderpore, and at Akra. In 1865 a Committee, of which the Honourable G. Noble Taylor was President, considered the questions of a railway bridge across the Hooghly, of wet docks, and of the provision of other facilities for trade. This report was forwarded to the Secretary of State with a despatch from the Government of India, No. 31, dated 5th April 1865. They pointed out that the "supposed dangerous character of the approach to Calcutta up the Hooghly" was not corroborated by the actual losses, which they deemed "not important viewed in relation to the whole extent of the trade." With regard to docks at Calcutta, they condemned sites on the Howrah side of the river as inconvenient for business, and the Akra site as distant and of doubtful accessibility. Balancing Kidderpore and Chitpore, they inclined to the latter for various reasons, and thought that the former "should not, at present at least, be adopted." But no action in respect of docks ensued, as the Committee did not recommend special aid from Government to their promoters, being of opinion that existing necessities would be met by the construction of jetties and the formation of a Port Trust. These measures were carried out with excellent effect, but we have now arrived at the stage when a further advance is required.

8 The present Committee have examined the Diamond Harbour scheme in paragraphs 58 to 64 of their report. Were docks constructed at Diamond Harbour, there would be a saving in pilotage charges, which is put down by the Committee in paragraph 59 of their report at R270-12 for a steamer of 3,000 tons, and R220-8 for a sailing vessel of 1,600 tons register. Other things being equal, the set-off against this saving would be the extra charges for railway freight on goods. For goods changing hands or warehoused in Calcutta the Committee estimate this charge at one rupee per ton, and they assume that for goods passing through Calcutta there would be no extra charge on account of the extra mileage; but the accuracy of this assumption may be questioned. We are unable to see that any saving in the aggregate

charge falling on the trade under the various heads of Pilotage fees, Port dues, Dock dues, Shipping and Landing charges, and Railway freight can result from establishing docks at Diamond Harbour; and we concur with the Committee in the opinion—

> "that every advantage claimed for docks at Diamond Harbour would be equally secured by docks in Calcutta, without putting merchants to the expense of providing new accommodation for the conduct of business, and entailing upon them the absolute loss of all that has been done in Calcutta."

Besides this, we consider as serious objections the liability of Diamond Harbour to cyclonic waves, and the difficulty of taking large vessels into docks on what will be for some months of the year a lee shore. We also concur with Lord Dalhousie and the Committee of 1865 in thinking the risks and inconveniences of the Hooghly to be over-estimated; and in any case it seems to us improvident to commit for ever the trade of the large portion of India commanded by Calcutta to the greater portion of those risks and inconveniences in order to escape the remainder.

Urgent need of increased accommodation procurable at Calcutta.

9. The need for greatly increased facilities for trade is amply proved by the facts given in paragraphs 15 to 18 of the report of the Committee of 1882, and in paragraphs 6 to 12 of that of the Committee of 1883. We may add that in a recent letter from the Board of Directors of the East Indian Railway it is mentioned that in the month of May last there were at one time over 1,100 wagons, or more than ⅛ of the whole of their railway stock, standing at Howrah unloaded, owing to the inability of consignees to clear their consignments. But the number is understated, for at one time it reached 1,600. The East Indian Railway Company were compelled to limit consignments from foreign lines, notably from the Oudh and Rohilkhand Railway. The loss of revenue on the latter line was estimated at not less than 2½ lakhs of rupees, and on the East Indian the net loss can hardly have been less than five times that sum. These figures represent the loss to the railways alone. The loss to trade generally must have been far greater. Nor should we be justified in assuming that the development of the trade in wheat, rice, and seeds will not proceed rapidly in years to come. That the port of Calcutta can be improved so as to meet all future requirements, the variety of not unreasonable projects in the past, and the present exhaustive examination, place it beyond doubt.

Wet docks preferable to jetties.

10. It will be seen from paragraph 15 of the report that, in the opinion of the Committee, 21 jetties might be provided on the Calcutta side of the river in positions where they could be erected without causing public inconvenience, and 20 on the Howrah side between the Botanical Gardens and the lower boundary of the port. But they estimate that the same amount of accommodation could be provided in a wet dock at not much greater cost, and they point out that vessels lying at jetties have neither the security nor the conveniences afforded by a well-arranged wet dock. One great argument for wet docks in preference to etties undoubtedly consists in their greater security in a situation exposed, as Calcutta is, to cylcones. But besides this, we concur with the Committee of 1865 in thinking, as stated above, that it is most undesirable to divide the accommodation, and to place half on the Calcutta and half on the Howrah side. Jetties, though costing less in the first instance than the proposed dock, will cost more to maintain; and, in the case of the existing town jetties, it has been thought necessary to set aside 2 per cent. per annum on the capital outlay as a sinking fund to meet the cost of renewing them from time to time (see paragraph 47 of the report). They would, therefore, be ultimately more expensive than docks. They might, indeed, be constructed in less time than docks, but the saving of time obtained would not compensate for these important and permanent drawbacks.

On sanitary grounds, it was formerly held that jetties would be preferable; but, as pointed out by the Committee, the experience gained in Bombay has proved that, if proper precautions are taken and sanitary regulations are enforced, no injury to health need result from the establishment of a dock, even in a populous neighbourhood, and with the crews living on board the ships. The water in the Bombay dock is salt, but it is by no means clean, as large quantities of sewage are still discharged into the harbour. The water with which the Kidderpore dock is to be filled will be fresh, but comparatively pure, and under the arrangements proposed it will be frequently changed. On the whole, therefore, we entirely concur with the Commissioners that docks, which are capable of indefinite extension, will, apart from the question of greater security, be in all respects preferable to jetties.

Calcutta side of the Hooghly, and Kidderpore site, the best for docks.

11. We concur with the Committee (paragraphs 21 and 53) in thinking that, although the East Indian Railway station on the Howrah side of the river may always receive a certain amount of traffic, the tendency, on the completion of the Hooghly Bridge, will be to concentrate the import and export trade on the Calcutta side of the river, avoiding thereby double establishments for many merchants and great inconvenience in the working of vessels loading general cargoes. The adoption of the Calcutta side will likewise, as they point out, greatly facilitate a connection with the Mutlah at some future time.

This accepted, there can be no question, we think, as to the superiority of the Kidderpore site over any other on the Calcutta side of the river. In 1865 the pontoon bridge at Howrah had not been constructed, and the erection of the railway bridge at Cossipore was in contemplation. But now it is evident that the existence of this pontoon bridge precludes the selection of any site above the bridge, and that Kidderpore is the nearest point to the south of the city on the same side of the river at which docks could be constructed, the Maidan and Fort William, on which no encroachment would be permitted, intervening. Certain alternative sites have been proposed further down the river at Akra; but, as shown in paragraphs 19 and 20 of the report, the Kidderpore site is in all respects more convenient, though on account of the land being more expensive at Kidderpore than at Akra, docks at the latter site might possibly cost somewhat less than the docks proposed. We concur with the Committee in the opinion that the docks constructed at Kidderpore should be connected with the town jetties by a tramway skirting the river bank, as well as with the railways now terminating at Sealdah by a branch from the South-Eastern line.

12. Considering the nature of the various properties along the Kidderpore foreshore, and the difficulty and cost of acquiring them, as also the expediency of possessing the usual machinery and appliances in close proximity to the large dry dock which it is proposed to construct, and the convenience of proximity to the anchorage, the Committee have selected the Government Dockyard as the best locality for the entrances to the new docks to pass through, and they propose that the Government should either take the Port Commissioners' dock at Sulkea in exchange, or accept a money compensation.

This question has received very careful consideration in our Military (Marine) Department, in view of the opinion of Rear-Admiral Sir W. Hewett, as to the inutility of the Dockyard, forwarded with your Lordship's Despatch No. 266 (Military), dated the 16th August last, and of the opposite estimates formed of it by Sir W. Mends and Admiral Bythesea. We have also lately deputed Captain Hext, R.N., Director of the Indian Marine, to examine the Port Commissioners' proposals, and have received his report.

We consider it essential that the Government of India should at all times possess a Dockyard establishment of its own, and consequently under full and complete control, the whole resources of which may, in the event of a war, be entirely available for the business of Government, and form an efficient safeguard against paying exorbitantly for perhaps inferior work. No present arrangements which might be made for placing the Port Commissioners' and the Seebpore College establishments at our disposal in such emergencies would, in our opinion, be reliable, and we therefore consider the proposal for the absolute transfer of the Dockyard, on payment of a money compensation, to be inadmissible.

An exchange of the Dockyard at Kidderpore for that belonging to the Port Commissioners at Sulkea Captain Hext reports to be undesirable, as the buildings and dock itself require expensive repairs which would take a long time in execution, and the site, being above the pontoon bridge, is inconvenient. In this opinion we concur.

We think, however, that all the necessary facilities for the proposed docks can be afforded, without detriment to the interests of the State, by adopting an alternative proposition by Captain Hext, in which we believe the Port Commissioners will concur, that the northern entrance to the docks should be moved one hundred feet lower down, and the portion of the Dockyard to the south of this given up to them, they on their part surrendering a small piece of land extending to Tolly's Nullah, re-erecting certain buildings, and paying whatever may be assessed as the net value of the balance against them in the exchange. By these arrangements, which are shown in the accompanying plan, all the more important buildings will be untouched; the Dockyard will be more compact, and the great advantage will be secured of close communication with the wet docks, where troops and stores would be embarked in the event of an expedition, and also with the graving dock which the new scheme is to comprise. It appears unnecessary to enter into further detail in this communication; but if your Lordship should sanction this proposition, for which we solicit approval, we shall be careful to provide, in the definite arrangement with the Port Commissioners, such stipulations and guarantees as may be necessary in the interests of the Marine Service of Government.

Eventual connection with the Mutlah.

13. The project of a ship canal between Calcutta and the Mutlah, a river admittedly much safer and more easily navigable than the Hooghly, is of old standing, and was investigated in 1876 by the Public Works Department. The estimate for construction then was for £1,545,000 (conventional sterling), but the present Committee, by varying the conditions, have reduced it to £1,100,000. The annual interest, lighting, and maintenance of the canal would, they reckon, impose a burden on the finances of the Port Trust of R8,88,021 a year. They suggest that this might in part be met by levying, as a toll on ships making use of this route, the amount saved on pilotage fees, which they estimate would amount to one-half the present charge on this account; or, adopting the figures given in paragraph 59 of the report, to half R1,084-8-0, or, say, R542 in the case of steamers, and half R909, or, say, R454 in the case of sailing ships. The balance they would defray out of the general profits anticipated from the docks.

The primary object of this canal is to avoid the risks of the Hooghly, and its construction would be a guarantee that the docks at Calcutta would be always utilised, and the trade of the port secure. Besides, many persons hold the opinion that Port Canning is destined to develope a trade of its own, independently of Calcutta. If it does, there would be an additional inducement to vessels to adopt the Mutlah route, were the canal constructed, and to call at Port Canning on the inward and outward voyage. That the canal scheme will be carried out at some future date we think very probable, but we see no present necessity for undertaking more than the survey, which alone we understand the Committee to recommend.

Financial aspects of dock scheme.

14. The Committee estimate the cost of the docks and subsidiary works at £2,307,000. After careful contrast of these estimates with those of the Prince's Dock in Bombay and of the docks proposed for Diamond Harbour, we think that this figure, with certain trifling additions, may safely be accepted as sufficient. But to this must be added an allowance for expenses connected with the transfer of the Government Dockyard, and also interest during construction, the amount of which will of course depend on the rate, the intervals of instalments, and the time expended in the work, but may be taken at from 20 to 25 lakhs. The Government of Bengal recommend a total of £2,650,000, or 265 lakhs of rupees, and it will perhaps be safest to adopt this figure.

The interest charge on the present capital debt of the existing town jetties, &c., is R1,69,000, so that on the completion of the docks the total interest charge would be R13,61,500, taking the new debt at 4½ per cent. The expenses of working the full traffic are estimated by the Committee as R13,74,000, at rates which much exceed those derived from experience in Bombay, and are probably susceptible of considerable reduction. The total charges amount, therefore, to R27,35,500, on a very liberal estimate.

The receipts, on the other hand, are put at R33,93,000, taking rates only a trifle lower than those now borne by the shipping, and assuming that the net tonnage of vessels frequenting Calcutta will increase about 35 per cent. in the next five years, so as fully to occupy the docks by the time they are ready. Considering that the net tonnage has actually risen 39 per cent. in the last five years, this assumption does not seem unreasonable.

The result should, therefore, be a surplus of about 6½ lakhs per annum. This result is attained, as we have said, by charging rates almost equal to those now borne. But it is questionable whether these rates, which are higher than those of Bombay, can be maintained in the face of competition, or whether the Port Trust will be justified in levying more than sufficient, on a reasonable estimate, to meet the whole working expenditure. For present purposes, however, while the eventual actual capital outlay is unknown, we think it safest to assume, for financial purposes, that the rates proposed will be levied. When the docks are completed, the question of rates should be settled on a review of the profits of the Port Trust after discharging their liabilities.

On the whole, therefore, we think the scheme may be accepted, without hesitation, as financially sound. Mr. Duff Bruce's experience of the actual cost of work at Calcutta itself, and his ability as an engineer, are a guarantee for the general accuracy of the estimates and the appropriateness of the details; while a further security is afforded by the fact that Mr. Bradford Leslie was a member of the Committee, and, though he eventually withdrew from it, he has approved of the whole in his capacity of Port Commissioner. We may add that the total debt of the Calcutta Port Trust, after the docks are completed, will not exceed three crores of rupees, whereas that of the Bombay Port Trust is now R3,83,80,000, and yet they have lately reduced the port charges, and still are in a position to borrow 83 lakhs more for the second dock about to be commenced.

Assistance from Government.

15. The Committee ask that Government should either (1) guarantee a loan to be raised by the Port Commissioners for the special purpose of the works, or (2) advance the funds as required, charging interest at 4 per cent. during construction and at 4½ per cent. subsequently, in accordance with the precedent of the Prince's Dock at Bombay.

It may be admitted that the Imperial Government are very intimately concerned in the provision of suitable docks and other arrangements for facilitating exports. By next year the Eastern Bengal Railway will be in our hands. The East Indian, the Calcutta and South-Eastern, and the Bengal Northern Railways are State lines. In the "Bengal Central Railway" we are interested as guarantors. It may therefore be said that the whole railway communication on both sides of the river is practically our own, and that as owners of this property we are called on, in our own interest, to do something for the port, as Railway Companies in England do. The docks are also likely, as pointed out in the Committee's 70th paragraph, to contribute to a more economical and effective control of the salt trade.

On the other hand, it is unnecessary to dwell here on the grave objections to the grant of State aid or guarantees, with which your Lordship is fully conversant. We are, therefore, of opinion that the Port Commissioners, before inviting our assistance, should satisfy us that they have used every means in their power to obtain the money on their own resources, on terms which, in view of their assured income, are not too onerous, and that they have failed to do so. But if we find such assistance to be necessary, it should not be granted except on the condition that the rates to be charged shall be fixed with our approval. It will be our object, having regard to the actual cost of the works and the condition of the trade of the port, from time to time, so to fix them as to put no unnecessary burden on trade, but to leave the Port Trust after payment of the interest stipulated a safe working margin, and no more.

Immediate relief to the export trade.

16. This question is dealt with in paragraphs 15, 16, and 17 of the Commissioners' report. It will be at least four years before the proposed new docks can be opened, assuming the work to be taken in hand at once. In the meantime the export trade will no doubt continue to increase (see paragraphs 7 to 12 of the report); and we entirely concur in the opinion of the Committee that, while the docks are being constructed, attention should be directed exclusively to the improvement of the cargo-boat service, and the extension of the boat wharves on the Howrah side of the river; and that it is not advisable to construct more ship jetties, either on the Howrah side below the Botanical Gardens, or to the south of the present No. 8 Jetty on the Calcutta side. As regards the former, we would refer to the 21st paragraph of the report, and repeat that we can see no advantage in dividing the trade between the two sides of the river until it has outgrown the accommodation that it is possible to provide on one side, assuming that both sides are equally accessible for produce from up-country, as will be the case at Calcutta after the Hooghly is bridged. We have already informed your Lordship that the East Indian Railway Company are making extensive alterations and improvements at their Howrah terminus to enable them to cope more successfully with the export traffic in grain and seeds, and purpose reporting fully hereafter. The matter has our careful attention, and we need not allude to it further in this place.

Miscellaneous recommendations of the Committee.

17. We may now notice some of the accessories of the Committee's project.

The scheme provides for access by boat canal to the dock in connection with a proposal understood to be now before the Bengal Government for locking, widening, and deepening Tolly's Nullah, and connecting it with the Circular Canal. The communication thus established between the docks and the whole eastern waterways of Bengal will be most advantageous.

The proposal to use the boat canal as the aqueduct for feeding the docks, the water being pumped into the dock to raise the level, and so to obviate, to some extent, the necessity of carrying the excavation down to treacherous substrata, appears to be feasible and judicious.

We concur with the Committee (paragraph 53) as to the impossibility of placing one part of Calcutta in competition with another. We can see no reason, from a railway point of view, for making any difference in freight charges on "up-country" through goods consigned to or from Calcutta, whether they are dealt with at Howrah or Kidderpore. The charges for long-distance traffic should be the same to and from all termini in Calcutta. This is in accordance with general practice.

Hooghly Bridge question.

18. One question remains for notice, which has been raised by the Committee, though only indirectly connected with the main question before them,—namely, whether the bridge over the river should be at Hooghly or Cossipore.

The Committee of 1865 gave the preference to the latter site, as being the nearest to Calcutta, at which a bridge would be safe from the risk of ships breaking loose from their moorings, in cyclones or otherwise.

We concur with the present Committee that there would have been many advantages in placing the railway bridge at Cossipore, or as close to Calcutta as possible, instead of at Hooghly. But it would have cost twice as much, and must, sooner or later, have been supplemented by a second bridge higher up the river (probably at Culna), to connect the East Indian Railway by a direct line with the Eastern and Central Bengal Railways. Moreover, it could not have obviated, for any length of time, the construction of a third bridge at Howrah itself, to serve the local traffic, which could always have been sent across the river in boats far more quickly and cheaply than by the detour of eleven miles which the bridge even at Cossipore would have involved. And there are advantages to the jute mills on the river above Cossipore, and to the jute trade, in a bridge higher up. Finally, the Committee are mistaken in supposing that the doubling of the Eastern Bengal Railway between Nalhati and Sealdah is necessitated solely by the Hooghly site. It would have been shortly needed, in any case.

On the whole, we are of opinion that the Hooghly site is supported by the preponderance of advantages; and as its abandonment would involve the sacrifice of a large sum already expended on the bridge now in active progress there, besides a delay of from two to three years in starting and constructing the larger bridge lower down, we consider that it is now too late to re-open the discussion. It will be observed that the Bengal Government concur in this view.

19. In conclusion, we would observe that the pressing need of improved facilities for the increasing trade of Calcutta cannot be too strongly insisted upon. The trade is rapidly expanding, and there is probably no public work on this side of India at the present time which can be said to be as important as the Calcutta Port improvements. The construction of docks will undoubtedly give great facilities, now wanting, to Calcutta merchants in the prosecution of their business, the process of loading and unloading cargoes will be considerably expedited, goods will be better and more conveniently warehoused, and the sorting and clearing of wheat before shipment will be promoted, while the general concentration of business will be a welcome relief to those concerned with trade and shipping. The measure now proposed is formally supported by an absolute consensus of official and non-official opinion, and has the entire approval of the local commercial public. We trust, therefore, that we may be favoured with sanction to its being undertaken at the earliest practicable date.

From Her Majesty's Secretary of State for India, to the Government of India,—No. 13 P.W., dated 6th March 1884.

I have had under consideration in Council the propositions of your Government, as explained in your letter No. 57 P. W., of the 30th October last, for providing additional facilities at the port of Calcutta for the present and future requirements of commerce.

2. The insufficiency of the existing accommodation has for some time been evident, and the rapid growth which has of late years taken place in the trade of the port has fully established the necessity for early measures being taken to supply enlarged conveniences for the business of the port. I am glad, therefore, to receive from your Excellency a definite proposal which will enable a decided judgment to be formed as to what action should now be taken for this purpose.

3. Your Excellency pursued a wise and judicious course in obtaining the opinion of those whose position and experience entitled them to be heard on this subject, and who were best able to offer valuable advice to your Government. The result has been the unanimous recommendation, by a body representing the interests concerned, of a scheme to which you are able to give your support.

4. The first and main question for consideration was whether wet docks were the best means of providing the requisite accommodation. The reasons given in paragraphs 10 and 11 of your letter under reply are, in my opinion, conclusive in favour of docks in preference to a large increase in the number of jetties, which, as you observe, would ultimately be likely to prove more expensive, and would in many respects be less secure and convenient. It is unnecessary, therefore, that I should say more on this point than express my concurrence in your recommendation that the principal accommodation to be provided should take the form of

docks—a conclusion supported, as far as I am aware, by the universal experience obtained at other places under like circumstances.

5. With regard to the situation most suitable for such docks, different opinions have from time to time been entertained, and various projects for them on either side of the river, above and below Calcutta, have been put forward. Diamond Harbour has more particularly been regarded with favour; and as far back as 1839, and again in 1847, proposals were made for constructing docks there. Lord Dalhousie, however, as your Excellency reminds me, "condemned the project," and it was dropped. Still many persons adhered to the opinion that it was a situation which possessed advantages over places higher up the river, mainly because it would afford the means of avoiding many of the dangers and difficulties of navigation, and the majority of the Committee of last year were favourable to it. But an important and influential minority, consisting of all the mercantile members, were unanimous in objecting to that locality, on the ground that the transfer of the export shipping business to a place so distant would lead to a great sacrifice of capital invested in Calcutta, and be otherwise wasteful and inconvenient. The Committee which was subsequently appointed to pursue the investigation, after full and patient deliberation, came to an unanimous conclusion against Diamond Harbour, and in favour of Kidderpore, as the place for the docks. The difficulties of navigation, which even in Lord Dalhousie's time were thought to be exaggerated, are now of less practical importance, being more readily overcome, owing to the general use of steam power and the superior character of the vessels employed in the trade of Calcutta. It is impossible to deny that there are considerable objections to the establishment of docks at a place so far removed from Calcutta as Diamond Harbour; and, as stated by the Lieutenant-Governor of Bengal, who is still inclined to see advantages in that site, "in the presence of the prevailing sentiment in Calcutta, no other project for wet docks than that which is under consideration seems practicable."

6. I accordingly confirm the conclusion of your Government in selecting Calcutta as the place for the future docks, and in adopting the Kidderpore site for them.

7. It is unnecessary at present to discuss the question of the proposed ship canal to the Mutlah, but the feasibility of making this communication, should circumstances at some future time make it desirable, may be recognised as one of the advantages appertaining to the Kidderpore site.

8. With respect to the work itself, it would appear that the design which accompanied the report of the joint Committee of September last will in several important particulars require careful reconsideration. I forward herewith copy of a memorandum by Mr. Rendel,* whose opinion I caused to be taken on the project that has been prepared at Calcutta. Mr. Rendel is the better qualified to offer advice on the subject, as he has not only recently had considerable experience in connection with important works of a similar character in this country, but is also acquainted with Calcutta and its neighbourhood and the peculiarities of Indian engineering work. His observations regarding the depth, size, and general proportions of the preposed docks, and the mode of constructing them, and his suggestion that a smaller dock area and one entrance would be sufficient, are deserving of serious attention; and I request that, before plans are finally prepared, I may be informed of the view taken by the professional advisers of your Government and of the Port Commissioners on his comments, particularly with reference to the relation between the magnitude of the proposed docks and the quantity of shipping to be accommodated, and after careful enquiry into the actual results obtained by experience in other ports. I request also to be furnished with any modified design which Your Excellency may find it desirable to recommend. You will readily perceive the necessity of observing the utmost caution in a matter of such importance in order to avoid, as far as possible, any mistake at starting.

9. The estimates for the cost of the work must necessarily depend upon its character and dimensions, and while there is any doubt as to the extent of the operations to be undertaken, no very accurate calculations can be made of the cost. There can be no doubt that it will involve a heavy expenditure, and that in all probability at least two crores and a half will be required. I observe that you accept the estimate of R2,65,00,000, including interest, during construction, and that you consider the net receipts may, after allowing for interest on the outlay and on the cost of jetties already erected, be fairly taken at R6,57,500; this, however being based upon the present rates borne by the shipping, which you think cannot be main, tained as competition with Bombay increases. The estimate of capital outlay, the accuracy of which in certain details has, you will observe, been questioned by Mr. Rendel, may be

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* Dated 4th January 1884.

reduced, notwithstanding the increased depth of the dock which he has recommended, if the proposal to diminish the area is adopted; but in any case, a large sum will have to be borrowed fort he purpose, and, until the docks are completed and earning revenue, the interest would virtually have to be paid out of capital.

10. With regard to the question as to how the money should be raised, I agree with your Government that, as a rule, it is most desirable that public bodies entrusted with powers to expend money on certain local objects should depend on their own resources. If, therefore, you have good reason for believing that the Port Trust Commissioners would be able to raise the requisite amount on such reasonable terms as would enable them to pay the interest and to give the advantages of the new works to the commercial community at moderate charges, I would support your view that they should be left to make their own financial arrangements without aid from the Government But it appears to me that the doubts entertained by the Commissioners are well founded, and that they might not be able to raise sufficient capital except on such terms as would entail a charge for interest which would, at all events at first, exceed the receipts, and which must therefore, if they are left to their own resources, be paid out of their borrowed capital, and so greatly add to the ultimate burden on their revenues. It may consequently be proper, considering the character of the project and the general and imperial interests concerned, as in the case of the docks at Bombay and the harbour of Madras, to give the Port Trust some financial assistance in carrying out the project. If this should prove to be the case, I consider that the aid of your Government will be better given by an arrangement similar to that carried out at Bombay for the purpose of enabling the Port Trust to acquire the foreshore properties than by the direct grant of funds supplied by the State.

11. There would be considerable objections to adding to the public debt so large an amount as that likely to be required for these works, which I am of opinion should not be permitted to bring any ultimate charge on the general revenues. I therefore think that it will be the best plan to authorise the Port Trust, by a local Act, to raise the money required under the guarantee of the Government, but subject to the control of the Government of Bengal, and that any necessary advances of interest should be charged against the Provincial revenues, on the understanding that such additional grant should be made to the Bengal Government as may seem equitable to your Government in order to meet the interest charge which could not be properly borne at the outset by the revenues of the Port Trust. Complete power should be reserved to the Local Government to require the Trustees so to regulate the charges for the use of the docks, and otherwise to apply their available income, as to provide a reasonable contribution towards the discharge of the interest on the dock loan from to time as it becomes due, and eventually to liquidate the whole sum that may be advanced.

12. If, therefore, after again considering the matter, you should not be satisfied that the Commissioners can dispense with your aid, I shall be prepared to receive a proposition from your Government for an arrangement on this basis. At the same time I should wish to have revised estimates founded on any new or altered scheme that may be put forward, and on the result of a careful consideration of the cost of each class of work included in the undertaking.

13. Pending the completion of the docks, it is, however, obvious that such steps as are possible should be taken for increasing the accommodation of the export trade, and you recommend that they should comprise the organisation of a suitable cargo-boat service, the extension of the boat wharves on the Howrah side of the river, and improvements at the Howrah station. These proposals have my approval. I agree also in the opinion that the establishment of water communication between the docks and the waterways of Bengal by means of a boat canal to Tolly's Nullah will be a most desirable, if not a necessary, part of the general arrangement. When the proper time arrives, this work may, therefore, also be taken in hand.

14. With regard to the question raised by the Committee as to whether the new railway bridge over the Hooghly, which is now in course of construction, should not be made at Cossipore instead of at Hooghly, I entirely concur in the view of your Government and of the Lieutenant-Governor of Bengal that any suspension of the operations now going on cannot be allowed, and that no change can be made. The present site was selected after much careful inquiry and consideration, and it promises, as you observe, a "preponderance of advantages."

15. There is one other matter alluded to in your letter which may be briefly noticed here, and that is the possible ill effects which the existence of docks at Kidderpore may have upon

the sanitary condition of the neighbourhood. I observe that you consider there is no cause for apprehension on this account, and I am glad to say that this view has been confirmed by assurances which I have received from Dr. Norman Chevers and Dr. F. N. Macnamara, whom I consulted, and who are competent judges on the subject. Copies of letters* from Dr. Chevers, containing suggestions as to precautions that might usefully be taken in carrying out the work, are forwarded for your information.

* Dated 28th December 1883 and 1st January 1884.

16. It is further necessary to remark that the questions of the effect of the projected docks on the existing defences of Fort William, and of the defences that the docks might require, do not appear to have been considered by the military authorities. I observe that in paragraph 11 of your letter approval is expressed of the connection of the docks with the jetties in Calcutta by a tramway skirting the river bank, as well as by a railway from Sealdah passing outside of the town. As such a tramway must pass close under Fort William, and between the river and the most frequented drives in Calcutta, it could not fail to be a source of much inconvenience to the public; and otherwise there appear to me very grave objections to its construction, which, moreover, could not be really requisite, if the other railway connection is provided. I request that these points may have your earliest attention.

17. Notwithstanding the important reservations which I have felt it necessary to make with respect to the design of the docks themselves, your Excellency will still be in a position to make a decided advance towards the execution of this much-desired improvement. When the necessary financial arrangements have been settled, all preliminary steps may be taken in connection with the occupation and clearing of the requisite ground, and for commencing any portions of the work the character of which is not dependent on the precise designs for those parts of the undertaking which will have to be reconsidered in accordance with the remarks made in this despatch. I trust that no avoidable delay will occur in coming to a conclusion on the whole matter. In the meanwhile the works on the Howrah side of the river, where the principal part of the shipping business must for some time be carried on, may be proceeded with at once.

MEMORANDUM ON PROPOSED DOCKS IN CALCUTTA AT KIDDERPORE, DATED 4th JANUARY 1884.

By Mr. A. M. Rendel.	*Remarks by Mr. Bruce.*
1. Whatever might once have been, or still may be, the danger of navigating the Hooghly, the transfer of trade first from sailing ships to steam vessels of moderate power, and more lately from steam vessels of moderate power to steam vessels of great and constantly increasing power, has so materially reduced them that with the precautions taken they seem at the present time of no great importance. Assuming this, then, inasmuch as the saving in sea freight by stopping ships at a point below Calcutta would be less than the cost of the additional land freight, and inasmuch as the general disturbance of business which the removal of the shipping from Calcutta would occasion would be very serious to private interests, the grounds on which docks at some point between Akra and Diamond Harbour can be supported seem to disappear.	
2. The navigation question being removed, the natural site for docks is the nearest point to the present seats of trade that circumstances will admit of,—that is to say, the docks should be placed as close to Calcutta as possible: but which side of the river should be selected?	

By Mr. A. M. Rendel.

3. The sole substantial reason that I can see for placing the docks on the right bank of the river is the fact that Howrah is the present terminus of the East Indian Railway. But this reason disappears on the construction of the Hooghly Bridge. The left or Calcutta bank then clearly becomes the proper one, and it may be adopted, I believe, without fear of the capital invested in Howrah being sacrificed, because in the port of Calcutta, as in that of London, a large business will doubtless be always carried on by barges plying between the railway stations on each bank of the river and the docks.

4. As to the best site on the Calcutta side, I do not think a better point than that proposed at Kidderpore could be selected. It is near enough for the convenience of business people in Calcutta, and it is far enough to provide space for the new quarter of the city which will doubtless grow up in the immediate neighbourhood of the docks without further pressure on the ground already occupied.

5. This new quarter would of course be laid out in the first instance with proper attention to sanitary matters. The docks themselves can never, I think, be a nuisance in this respect.

6. In regard to design, the arrangement proposed in the Committee's report is of the usual description.

7. It comprises a basin, about ten acres in area, with two entrances on the one side into the river, and with two passages on the opposite side into docks beyond it. One of the river entrances is a lock of 60 feet wide and 450 feet long. The other has a single pair of gates only, and is 80 feet wide. The passages between the docks and the basin have both a single pair of gates; one is 80 feet and the other 60 feet wide.

8. The docks are two in number, but they are separated by a road only. They are 600 feet wide throughout, and their united area is 101 acres.

9. They are walled all round, the total length of quay wall available for the berthage of ships being 16,855 feet lineal, and ample space is provided behind the walls for sheds, railway, road, and so on. A boat dock communicating with them by a lock connects them with the cannals with surround Calcutta, and two large dry docks opening into the basin provide for the examination and repair of shipping.

10. In respect to depth, that of the basin and of its entrances from the river is to be

Remarks by Mr. Bruce.

By Mr. A. M. Rendel.	*Remarks by Mr. Bruce.*
14 feet below the level of the present Kidderpore dock sill, which appears on the plans to be two feet below low water (what low water is not stated), and is taken as datum. The depth of the docks themselves and of the passages between them and the basin is fixed at 10 feet below this datum. Spring tides rise, it is stated, from 15 to 22 feet above Kidderpore dock sill; neap tides rise occasionally, it is stated, to only 11 feet above it. But the table of tidal range attached to the report shows sometimes even less than this.	Lowest low water spring tides. In February and March, when strong northerly winds are blowing, neap tides may not reach 11 feet, but this only occurs once or twice in a year.
11. The depth in the basin and its river entrances at high water would therefore vary from, it is said, 24 feet as a minimum to 36 feet as a maximum. The depth of the passages between the basin and the docks and of the docks themselves would vary from 20 feet to 32 feet.	
12. For all, therefore, but a few days in the year it is estimated that vessels drawing 24 feet of water will be able to pass between the basin and the river at high water, and very generally vessels of still larger draught could be admitted.	
13. But as the bottom of the docks will be four feet higher than that of the basin, and as the same depth will be necessary to keep ships afloat in both, the water level of the dock must be kept at a much higher level than that of the basin, and when it is necessary to pass vessels between them, their levels must be equalised by passing water in sufficient quantity from the docks into the basin.	
14. This means that the docks must not only be deep enough to keep the ships in them afloat, but that they must have such extra depth as will enable them to supply the water requisite to raise the basin level to their own as often as the traffic requires. They must also supply water to the river lock for working it, and for scouring both river entrances at low water and the general waste that is always going on at dock gates and sluices.	
15. The inflow from the river at high water may perhaps be sufficient for all these purposes during the rains, but not at other times. It is proposed, therefore, to maintain the water level of the docks by pumping water into them. The depth proposed for all parts of the scheme seems to me to be insufficient, and pumping should, if possible—and I think it can—be avoided.	*Paragraph 15.*—It is during the rains that it is most important to prevent, as far as possible, the river water from running straight into the dock, on account of the large quantity of silt which the water then contains. Pumping could be avoided by increasing the depth of the dock, but it would be a great mistake, for reasons given in remarks on paragraph 17, to do so, and it would materially increase the first cost of the docks.
16. Ships on the Hooghly will, as on the Thames, and with much more cause, lock and	*Paragraph 16.*—It is not quite clear from the remarks made by Mr. Rendel in this paragraph

By Mr. A. M. Rendel.	*Remarks by Mr. Bruce.*
unlock, I believe, on the rising tide only. I doubt if any large ships will try to pass in or out of the docks after the tide has begun to fall. For if by any accident whilst doing so she could touch the ground on the falling tide, she could not get off again, and as the tide fell she would be wrecked and perhaps block up the dock entrance also. There must, therefore, be water enough on the river entrances to pass heavy ships between the river and the basin at least an hour before high water. To allow of this, the river entrances should, in my opinion, be at least three feet deeper than is proposed. I speak on this point with the experience of the Albert Dock before me, where, although the present entrance has 26 feet on its sill at ordinary neaps and 30 feet at ordinary springs, a new entrance five feet deeper is about to be built because these depths are found insufficient. The basin should be at least two feet deeper than the entrances, because mud will be sure to be deposited in it, which cannot be removed until it has accumulated to some little depth.	whether he has noted the reason given by the Committee in paragraph 25 of their report for fixing the level of the sill at 14·00 feet below datum. The Committee say: "In fixing the depth of the sill at 14 feet below datum, the Committee have been guided by the fact that a greater depth would be of no practical advantage, as vessels which could not leave the dock with this depth of water over the sill could not at such times proceed down the river." In the Thames the case is different. Vessels can there get to sea at any state of the tides, and the lower the sill, the sooner on each flood tide will a vessel be able to get out. Docking and undocking can be commenced at a longer interval before high water, and more time is given for passing vessels into and out of dock. But in the Hooghly, vessels drawing 22 feet of water could not proceed to sea during neap tides, and on such tides the lowest depth of water over the lock sill (with the exception of one or two occasional tides in March, when the depth might fall to 24 feet) would be 25 feet. When a vessel drawing 24 feet of water can proceed to sea, there would be at least 27 feet of water on the lock sill, and when a vessel drawing 26 feet could proceed down the river, there would be at least 29 feet over the sill. If the dock entrances were on the Mutlah, I would make them the depth Mr. Rendel proposes—possibly deeper; but there is no necessity for it in the Hooghly. The lock sills were designed by me originally to be 16 feet below datum, but in consideration of the difficulties that may be experienced in getting the foundations in, and the facts above stated in respect to the draught of water at which vessels could get to sea, it was decided to reduce the depth to 14 feet—the depth to which it is absolutely necessary to go. If, however, it is found that the wells can be carried down without great expense to the depth originally intended, no extra expense will be incurred on account of either the brickwork or gates, as I did not alter the estimates when we altered the level of the sill from 16 feet to 14 feet below datum, but instead raised the level of the coping to 26 feet from 24 feet over datum, at which level it originally stood. There is, however, no absolute necessity to keep the height of the coping more than 24 feet above datum, as the highest spring tides during the freshets seldom rise to 22 feet. The present jetties are 24 feet above datum, and 24 feet will be sufficient for the dock entrances.
17. Again, though pumping is sometimes resorted to in England to maintain a higher level in docks than the tide alone will secure, it is only employed when the docks have	*Paragraph 17.*—In the case of the Kidderpore Docks, pumping will be resorted to, *1st*, to avoid accumulation of silt in the dock; and, *2nd*, to avoid going deeper than is absolutely neces-

proved either too shallow for the trade which uses them or unable to supply lockage water, or both, and cannot be deepened. For these reasons the London Dock at Shadwell has been maintained by pumping for many years at a fixed level higher than high water, and for similar reasons pumps are now being provided for the Albert and Victoria Docks. But pumping in both cases was an afterthought, to meet an unforeseen difficulty, and I am satisfied that it would be a grave error to deliberately design docks dependent on pumping, unless there be some absolute necessity for doing so, which I cannot see in the present case. If it be supposed that accumulations of mud in the docks will be avoided by pumping, I think there will be disappointment. More mud will, I believe, be brought in by the pumps than would be brought in by the tide. The mud will not, I think, be deposited in the canals as supposed, because the stream of water leading to the pumps will alone be sufficient to keep it in suspension; and even if it was deposited in the canals, it must be dredged out of them at as great expense as in the docks.

The amount of water required to maintain the dock level will also, I believe, be found very far in excess of any estimate, for the loss by waste, leakage, levelling, and lockage is far greater in practice than in theory. I should therefore strongly recommend that the passages between the docks and the basin be made at least five feet deeper than is proposed, and that the docks, for the same reason as the basin, should be made two feet deeper than the passages, or seven feet deeper than is proposed. Pumping will not then be required.

To make the docks so much deeper would no doubt increase their first cost, though not, as I judge from the borings, the difficulty of constructing them. But against this increase must be put the first cost of the pumps and the capitalised value of the annual charge for pumping, which would go far towards covering it.

sary into a soil which experience has shown it may be very difficult to work in.

In respect to the first-mentioned reason, Mr. Rendel thinks that we will be disappointed, and more mud he believes will be brought in by the pumps than by the tide. If, however, we are not mistaken, and the silt is deposited in the canals, he says it must be dredged out of them at as great expense as if it had been deposited in the docks. All experience here shows that we will not be disappointed in respect to the mud being deposited within the first mile or two after it enters the canal. And when it is considered that the area of the canals from which the water is to be pumped is about 359 acres, and that the canal leading to the pumps is 150 feet wide and 10 feet deep, it will be seen that the flow of water to the pumps will not be sufficient to retain the mud in suspension. As a matter of fact, the velocity of the water in the canal leading to the pumps will only be ·076 foot per second, while it requires a velocity of ·25 foot per second to keep fine particles of mud in motion. Although we may not be able to keep the docks absolutely free from silt by pumping, yet the quantity that will get in will be infinitesimal compared with what would enter the docks if they were constructed at a lower level, and the tide allowed to flow in and out daily. It is true the mud deposited in the canals will have to be dredged, but the dredging operations will be conducted at much less expense and without occasioning inconvenience to the vessels in the docks, or taking up valuable quay space. The dredging in the canal will be done at a depth which will never exceed 10 feet, while in the low-level docks dredging would have to be done at a minimum depth of 26 feet during neap tides and 33 to 36 during springs. Neither in first cost nor in working charges is a dredger to work to 10 feet as expensive as one to work to 30 feet, both being designed to do the same amount of work.

The estimated cost of the engines and pumps is R2,50,000, and the annual cost of working them I estimate at R37,000. This is for pumping in twelve hours sufficient water to raise the level of the docks one foot; but on an emergency the power provided would be sufficient to pump four feet of water in 24 hours. R37,000 represents the interest and sinking fund on a capital of about R6,00,000, so that the capitalised value of the pumping arrangements may be taken at R8,50,000. As regards the amount of water required to maintain the dock level, it is very difficult, in fact impossible, to estimate what may at first be required to make up for leakage; but the river silt forms an excellent puddle, and will

By Mr. A. M. Rendel.

18. A large saving might also be effected by making the docks 450 feet wide instead of 600 feet. If it be thought necessary to provide for turning ships, a length of 800 feet might be made 600 or 700 feet wide; but the Albert Dock is only 490 feet wide, and might be less without inconvenience. It is probable that a width of 600 feet was selected, because it was supposed that all vessels must turn round when they leave the dock, for there can be no other reason for such a width, which of course involves a cost which should not be incurred without good cause. But vessels will not need to turn to leave the docks. In London, as a rule, they leave the dock stern first, and I believe they will leave docks in the Hooghly in the same way, for the same reasons.

Remarks by Mr. Bruce.

very soon render the docks perfectly tight against leakage through the soil. For lockage and leakage at the sluices and gates the quantity provided for will be ample.

Now, suppose that instead of a high-level dock, as recommended by the Committee, a low-level dock is adopted, and the quay walls and bottom of the dock carried down to the depth recommended by Mr. Rendel, and pumping thereby avoided, the extra cost, taking the same rates as in former estimate, would be—

	R
Brickwood	16,63,632
Well-sinking	2,31,060
Excavation	4,83,600
Lowering entrances . . .	1,70,000
	25,48,292
Contingencies, 20 per cent. . .	5,09,658
Total .	30,57,950

against R8,50,000, the capitalised value of the pumping arrangements and first cost of pumps, and which requires an actual cash expenditure of only R2,50,000.

Paragraph 18.—There would, of course, be a saving if the docks were made 450 feet wide instead of 600 feet. The saving on a high-level dock, as recommended by the Committee, would be about R10,29,369. I am confident, however, that a dock 450 feet wide would not be found suitable for Calcutta. It was not merely for the purpose of turning vessels that the docks were designed of the width proposed. If the object had been merely to turn vessels, that could be attained, as pointed out by Mr. Rendel, by widening a length of 700 or 800 feet to 600 or 700 feet, leaving the remaining portion of the docks 450 or 500 feet wide. But even this would not have been necessary, for vessels wishing to turn could have done so in the tidal basin.

The reason for giving the extra width was to provide accommodation for vessels that will have to remain in the docks waiting for cargo, or only taking in small quantities from cargo boats, and which would not consequently require quay space after they have discharged, except to take in such cargo as was brought by the railway, or in carts.

If the vessels actually loading or unloading at the quays were only to occupy the docks, a width of 450 feet or 500 feet would be sufficient; but we have to provide for a much larger number of vessels than we could provide quay space for. Of the class of vessels that are now coming to Calcutta, the quays would not conveniently accommodate more than 43 or 44; but during the year 1883—a year in which the export trade has been unusually dull—the actual number of vessels that would have been in dock at the end of each month is shewn in the following statement*:—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average number per month in port during the year.
Number of sea-going vessels in port on the last day of each month during 1883	100	70	61	83	101	109	105	98	98	98	98	106	94
Deduct 10 per cent. of the number that might not use the docks . . .	10	7	6	8	10	10	10	9	9	9	9	10	9
	90	63	55	75	91	99	95	89	89	89	89	96	85
Deduct 10 as the average number of coasting steamers in port which would not probably use the dock . . .	10	10	10	10	10	10	10	10	10	10	10	10	10
Balance that would have been in dock at the end of each month in 1883 . .	80	53	45	65	81	89	85	79	79	79	79	86	75

Deducting from these numbers 44 vessels which could be accommodated at the quays, there remain for nine months in the year about 36 vessels which would have to be accommodated at the moorings down the centre of the docks or in stage berths. If placed three abreast in the moorings, these vessels would occupy (allowing space for cargo boats between) a width of about 200 feet, and the moorings could then only accommodate 36 vessels. With the moorings full, and two tiers of vessels at the quays, we could not get more than 116 vessels into the docks, which would then be so crowded that it would hardly be possible to move the vessels about. There are over 5,000 boats in port of Calcutta licensed to take cargo to or from vessels in the stream. The dock will, to a large extent, do away with the necessity for these boats, but still it is perfectly certain that a large amount of business will still be conducted in cargo boats. It is impossible to estimate the number that will enter the docks, but it is quite certain it will be very large. In addition to these boats, which ply regularly within the port for hire, hundreds of native boats arrive and depart daily by the canals bringing in jute, seeds, and grains, and taking back salt and piece-goods to the eastern districts of Bengal. It is for the accommodation of this trade that the boat dock in connection with the canals has been provided, but numbers of these boats will require to go alongside of vessels in the dock.

If the trade of this port is to be conducted in docks, we must have water space as well as quay space. With 76 vessels in dock (which

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* This statement does not include tug-steamers, inland-steamers, or flats. The number of these vessels at the end of each month during 1883 was as follows:—

January	34	May	33	September . . .	41
February	29	June	36	October . . .	44
March	34	July	33	November . . .	36
April	31	August	35	December . . .	41

would be about the average number throughout the year), the whole of the quay space and moorings would be occupied, and the space left would not be more than sufficient for the cargo boats and native boats, and afford room for vessels to manœuvre when entering and leaving the docks. I think it would be a great mistake to make docks for Calcutta less than the width proposed, and even with this width strict regulations will have to be enforced to prevent the docks from becoming overcrowded with cargo boat and native bhurs.

The traffic on the river has now increased so much that with a large number of ocean-going vessels moored in the stream there is hardly sufficient room to move vessels about safely, and during strong tides cargo boats are constantly getting damaged. The coast traffic carried on by the British India and the Asiatic Steam Company's steamers has, for want of accommodation, to be conducted entirely at moorings in the stream. When the docks are completed these vessels will occupy the jetties, or a portion of them, while full occupation for such jetties as the coasting and China steamers do not require will be found by the steamers and flats of the India General, the River Steamers, and the Flotilla Companies, for none of which is adequate accommodation provided at present. The new passenger service recently started on the river promises to develope a very large traffic, for which already we have difficulty in providing adequate accommodation, in consequence of the whole river frontage being blocked up by ocean-going vessels, and the landing-places and channel crowded with cargo boats and native bhurs. By the time the docks are finished, I expect it will be found necessary to send all ocean-going vesssels, whether steamers or sailing ships, into the docks, and give up the river frontage for the coasting and inland steamers. Either this must be done, or more mooring-accommodation provided lower down the river at Garden Reach, where it would be very inconvenient to work the ships. But it will, I think, be found that during the freshets every shipmaster will desire to place his vessel in the docks. The long vessels of the present day do not lie as easy in the moorings (which are in a strong current) as the shorter vessels of the past, and no captain will run the risk incurred by lying at moorings in the stream if he can get into a quiet dock.

The following statement shows the number of ocean-going steamers and sailing vessels in port at the end of each month for the past three years, and I would draw attention to the figures for the months of July, August, September, and October, when every vessel would, if possible, go into the dock :—

	1881.	1882.	1883.		1881.	1882.	1883.		1881.	1882.	1883.
January . .	117	101	100	May . .	67	97	101	September . .	90	134	98
February . .	73	67	70	June . .	76	87	109	October . .	101	127	98
March . .	50	61	61	July . .	71	106	105	November . .	89	123	98
April . .	46	49	83	August . .	90	108	98	December . .	88	136	106

19. I may perhaps explain how docking and undocking is effected on the Thames.

Dock entrances on the Thames are designed, as far as circumstances will permit, pointing up the river, and, as I have before said, the docking and undocking of large ships only goes on whilst the tide is rising. When a large vessel arrives from the sea at the entrance of the dock to which she is bound, she turns, and then with her bow to the tide enters bow first. When she leaves the dock, she does so generally stern first. Her bow then points down the river in the direction she wants to go and against the tide. The reason for adopting this method is that a ship can be kept under more command when she is moving against the tide than when she is moving with it. The practice of the Thames must, I believe, be that of the Hooghly also, and I note that the position selected for the lock is well placed for it; but I gather from the position of the single entrance in the river, and the manner in which it is proposed to work it, that it is desirable to call attention to the subject. I doubt if the single entrance will be of use in proportion to its cost. I think the design of the basin admits of improvement. In the present design difficulty will be found, and much time will be lost in getting ships pointed to the dock passages after they have entered the basin, and *vice versâ*, the more so as the basin will undoubtedly be much crowded, especially with barges. This is a serious difficulty, and it will also prevent the basin from being used as it ought to be for the berthage of ships. The dry docks should for the same reason be placed in the dock instead of in the basin. The basin of the Albert Dock, I may mention, is the most courted part for the berthage of ships.

Paragraph 19.—I believe it will be found in practice that vessels, as a rule, will undock on the rising tide and during the last hour's flood; but it will cause considerable delay to many vessels if they are not permitted to enter the dock at slack water,—*i.e.*, after the tide has commenced to run down in-shore, while it is stationary or still running up in mid-stream. Most vessels try to cross the "James and Mary" Sand at the top of high water when the tide has become easy, and they can then only reach Calcutta at slack water. If they are not allowed to enter the locks after the tide has commenced to fall, they will be detained in the stream at least 12 hours, and possibly 24 hours.

The single entrance was designed especially to meet such cases, and to enable vessels which arrived at slack water (which fully 80 or 90 per cent. of the vessels now do) to go straight into the dock. Again, during neap tides, in the freshets, there is no flood tide at all; the level of the water rises, but the current is always down stream, and it would then be impossible to dock any vessels by the upper entrance; the lower single entrance only could then be used. There is, as pointed out by Mr. Rendel, some risk in docking on a falling tide, but, with the entrances as arranged, it will be so small that it would not deter any vessels from entering immediately after the turn of the tide. During the last hour of flood, and the first hour of the ebb, the actual rise and fall does not exceed one foot. Undocking will begin about an hour before high water, and the tide will then have risen to within a foot of its full height. Vessels would then be dropped out stern foremost, through the upper entrance, or as the tide got easier they could be steamed out head to tide through the single entrance. Vessels that had entered the port on the flood tide would turn in the anchorage above the docks, and go into dock by the upper entrance, but vessels which arrived at slack water would steam straight into the dock by the lower single entrance and never turn at all.

The arrangement of the entrances and basin recommended by the Committee has been approved by every nautical man, with local experience, who has seen the plans. Captain Hext, R.N., Director of the Indian Marine,

By Mr. A. M. Rendel.

20. In respect to construction, the wall of the dock and basin, and the whole of the entrances, are to be founded on wells. This method is common in India for bridges, and has been adopted in the Thames by myself, and on a much larger scale in Glasgow by the Engineer of the Clyde Trust for the foundation of quay walls. But the wells are shown sunk only about four feet below the bottom of the docks. In such ground as will be met with in Calcutta, I feel sure that if the wells are not sunk 10 or 12 feet below the bottom of the dock, the ground behind them will sink and flow under them into the dock, after, if not before, the water is let into them. This of course would be fatal to the walls.

Remarks by Mr. Bruce.

expressed his unqualified approval of the plan, and this opinion is also entertained by Captain Carew, Deputy Director of the Indian Marine; Captain Atkinson, Marine Superintendent, British India Steam Navigation Company; the late Mr. Yates, Deputy Conservator of the Port; Lieutenant Petley, R.N., Deputy Conservator of the Port; Mr. Behrend, Deputy Harbour Master; and many others.

The tidal basin cannot be used for the berthage of vessels, and there is no room for sheds without encroaching on the Government Dockyard, or the premises of the India General Steam Navigation Company, and without sheds quay space is of little value.

With regard to the graving docks, I think it would be a great mistake to remove them from the basin. If placed at any other position in the docks they would seriously interfere with the railway communication to the dock sheds, and necessitate an entire re-arrangement of the lines within the dock enclosure. In their present position they do not interfere with anything, and are placed in the Government Dockyard, where every convenience exists for executing repairs to vessels in the docks. The Dockyard authorities are quite prepared to give the land required for the graving docks, where they could dock close to their works the largest vessels of the Indian squadron, but it is certain they would most strongly object to give up the same land for the construction of cargo sheds.

While vessels were being docked or undocked, the admission or exit of barges by the river entrances would be entirely suspended, but they could use the canal entrance specially provided for them at all times.

Paragraph 20.—In the estimates I have allowed for sinking the wells to a depth of 5 feet below the bottom of the docks and basin. This depth will be quite sufficient, unless very bad soil is met with, in which case the depths to which the wells may have to be sunk will depend entirely upon circumstances, and will have to be determined as the work progresses. In the design for the docks proposed to be constructed at Diamond Harbour, Mr. Wawn, the Special Engineer, designed the quay walls to be carried only 5 feet below the bed of the dock, and this design was approved by the two Chief Engineers of Bengal, Mr. Levinge and Colonel Trevor, and also by Mr. Bradford Leslie. It is very probable portions of the walls will have to be carried to the depth suggested by Mr. Rendel—possibly deeper; but the allowance for contingencies will, I hope, cover such cases. If the soil turns out to be similar to that found when putting in the foundations of the new locks at Chitpore, a depth of 5 feet will be

By Mr. A. M. Rendel.	*Remarks by Mr. Bruce.*
	quite sufficient. The bottom of the foundations of the Chitpore lock, which was put in dry, and without wells, is at the same level as the bottom of the proposed high-level dock, and very little difficulty was experienced in excavating to this depth at Chitpore. Should the ground, however, prove to be as unfavourable as Mr. Rendel anticipates, it is a very strong reason for not adopting his suggestion to make the docks on a lower level so as to avoid pumping.
21. I need not perhaps enter into the details of the entrance jetties, of the laying out of the quays, of the sheds, and so on. They are all of the kind now generally adopted in this country.	
22. In respect to cost, I have too little information to enable me to say much. The ground on which the docks will be built is, I fear, not good, but how bad can only be determined by actual trial on a considerable scale. There is, however, no reason to suppose that a better site in this respect can be found anywere else in the neighbourhood of Calcutta, and I do not doubt that the construction of docks by some means or other is feasible upon it. But I should notice that the prices for excavation seem low for this class of work even in India, and that 10 per cent. only is provided for engineering and contingencies. Now, 10 per cent. is barely sufficient in India to cover engineering, and at least 15 per cent. more should be provided in such a case as this for contingencies alone. Modified, therefore, also as I propose in respect of depth, I fear that if I were to make an estimate it would be largely in excess of that of the Committee.	*Paragraph 22.*—I do not think the rates are too low. Brickwork is estimated at R36 per 100 cubic feet, and earthwork at R20 per 1,000 cubic feet. If the work is executed departmentally, the actual cost of the brickwork should not exceed R30 per 100 cubic feet, which would leave a margin of R6 per 100 cubic feet for pumping, &c. The rate for earthwork will be ample, even if we have to dredge out the lower part of the excavation. The rates are the same as those on which the estimates of the Diamond Harbour docks was based, and I consider them sufficient. In our estimate we allowed 10 per cent. for contingencies; but the Government of Bengal, when forwarding the scheme, added 10 per cent. to the total estimated cost to cover the charges for tools and plant, and interest expended on capital while the works are in progress. Mr. Rendel considers 25 per cent. should be allowed to cover these items, but I think it will be found that the 20 per cent. already included, which brings the total cost up to 265 lakhs of rupees, and leaves a margin of 46 lakhs of rupees for engineering, interest, and contingencies, will, with the liberal rates for the work, be found sufficient.
23. But I would suggest for consideration whether a much smaller scheme would not be sufficient for the present. In these days of rapid despatch, ships stay in dock but a short time, and therefore a very small amount of water space well laid out in respect of quay wall and quay space will provide for a very large trade. Would it not be sufficient, therefore, to confine operations for the present to a basin and dock measuring together 50 acres? Such a basin and dock might be designed to supply between 11,000 and 12,000 lineal feet of quay wall available for the berthage of ships, and one lock, say 500 feet long and 70 feet wide, without other entrance between the	*Paragraph 23.*—I hope the foregoing remarks show that any less comprehensive scheme would not suffice. The Bombay Docks are already being doubled. In Calcutta we could ultilise a dock as large as that proposed with the shipping now frequenting the port, and with a steady annual increase in the tonnage, it will be found, by the time the Kidderpore Docks are finished, that unless vessels load and discharge much quicker than they do at present, and which, it is hoped, the facilities to be given will enable them to do, the docks will not then be large enough for the shipping that will want to use them. A smaller dock with more quay space in proportion to water area could very easily be designed, but it would not be as suitable for

By Mr. A. M. Rendel.	*Remarks by Mr. Bruce.*
basin and river; and one passage with a single pair of gates between the basin and the dock would supply all the necessary entrance accommodation. No more was supplied to the Victoria Docks built 30 years ago, or to the Albert Dock designed 10 years ago. Although each measures about 90 acres in area, and although the large traffic alone of the Victoria Docks keeps its lock employed about seven hours of every tide, no more would be now required if only the present entrances were deep enough.	the trade of Calcutta. The entrances recommended by the Committee in their report were designed in consultation with those best acquainted with the requirements of the port. No better arrangement in respect to the entrances can be devised. Numbers of plans showing different arrangements of docks and jetties might be prepared, but I doubt very much if any of them would be better than that proposed. If another design has to be prepared, considered, and approved, it may be years before the work is commenced. Mr. Rendel has advanced no good objection to the scheme. His opinions, briefly stated, are that he approves the site and the general arrangement of details; but he considers a low-level dock better than a high-level, and that a smaller dock with a single entrance might be sufficient for the present. A low-level dock would cost more than a high-level, even after taking into consideration the capitalised value of the cost of pumping; and would be more difficult to construct and to keep clear of silt. The area of the docks proposed by the Committee is not too large for the requirements of the trade of Calcutta. A smaller dock with a single entrance would neither meet the requirements of the trade nor the shipping.
24. In conclusion, I think it right to say that in my judgment docks in Calcutta cannot be safely made the subject of a contract for execution. There are too many contingencies to be encountered, and consequently too many chances either of failure to complete a contract or of exorbitant demands for extras, or both. Contracts for docks even in this country too often lead to troubles of this kind, especially when bad foundations are encountered. The departmental system should certainly, I think, be employed in Calcutta. A. M. RENDEL. *4th January 1884.*	*Paragraph* 24.—In the opinion here expressed I entirely agree. Contracts may be let for the supply of bricks, lime, cement, gates, sheds, and machinery, but the actual construction of the works should be carried out by our own engineers on the departmental system. W. DUFF BRUCE. *30th April 1884.*

Demi-official from NORMAN CHEVERS, Esq., M.D., to Juland Danvers, Esq.,—No. 2, dated 28th December 1883.

Having been ill, I fear that I may not be able to call upon you for a week or ten days. In the meantime I entirely concur with Dr. Macnamara in the belief that the existence of wet docks at Kidderpore cannot in any degree injure health in Calcutta or in their own immediate vicinity.

On the other hand, much of Kidderpore is thickly covered by native bazar. Should it be decided to dig there, there might be sickness in the neighbourhood while the process of excavation was in progress.

Could you be so very kind as to send me a plan, as I cannot quite understand where the docks would be placed, most of the Hooghly bank of Kidderpore being occupied by the dockyard, &c. ?

Demi-official from NORMAN CHEVERS, Esq., M.D., to Juland Danvers, Esq.,—No. 3, dated 1st January 1884.

Upon your note of yesterday, I have again considered the subject of the wet docks, and have examined the map. As the docks will, of course, be well kept, there cannot, I believe, be any reasonable fear that their presence will in the very slightest degree imperil public health. Any ill effects which may arise while the excavation is in progress will be reduced to a minimum by clearing the entire area at once of its huts, so that no one may sleep close to the hollow and the recently-excavated soil. Thus, while extensive earthworks were going on at Port Canning, the coolies employed went and returned by rail daily. I see that the work will touch two good roads, by which the earth may be carted away to fill noisome hollows. Some million tons of such earth, judiciously laid down in the city and its suburbs, would be a most invaluable benefit to public health.

With sincere thanks for your kind wishes.

Note by R. B. Buckley, Esq., C. E., Offg. Under-Secy. to the Govt. of India in the P. W. Dept. on some Engineering points connected with the project for the Kidderpore Docks.

The engineering points connected with this matter of the Calcutta docks are most interesting. With reference to several of the points, experiences gained on the Calcutta canals may not be without some value. These canals occupy a position with reference to native boats exactly analogous to that which the Kidderpore Docks will occupy with reference to ships A new lock, with a chamber 40 feet wide, and a large basin, which was constructed at Chitpore, while I was Executive Engineer of the canals, is similar in many respects to the proposed dock entrances at Kidderpore. The Calcutta canal is fed, as Mr. Rendel would feed the dockss through a sluice at the entrance, and we had to contend in the canal with three of the difficulties which may assail the docks,—difficulties with foundations, difficulties with silt, and difficulties with unclean water.

Mr. Rendel suggests the following modifications in Mr. Bruce's design:—

(1) That the depth of all parts of the docks should be increased.
(2) That the idea of pumping should be abandoned.
(3) That the docks should be fed by the tide from the entrances.
(4) That the width of the dock should be reduced to 450 feet.
(5) That the design of the basin should be altered.
(6) That the dry docks should take off from the dock proper and not from the basin.
(7) That the foundation of the dock walls should be carried down to 10 or 12 feet below the bed of the dock.

Mr. Rendel thinks that a much smaller scheme might be sufficient for the present. He also throws some doubts on the sufficiency of the estimates.

With reference to the first point, Mr. Rendel first, discusses the depth of the entrance, from the river to the basin. Mr. Rendel quotes precedents which are of weight in themselves although this weight is, as Mr. Bruce has shown, greatly reduced by the peculiar circumstances of the Hooghly. Mr. Rendel would deepen the entrances by 3 feet, so that there should be ample time for ships to lock and unlock on the rising tide. Mr. Bruce justifies the level of the outer sills (14·00—Kyd's Dock sill) by a reference to a fact stated in the report, but which Mr. Rendel appears to have overlooked, that " a greater depth would be of no practical advantage, as vessels which could not leave the dock with this depth of water over the sill could not, at such times, proceed down the river." This may be, perhaps, more plainly stated by saying that the sill level has been fixed at about the same level (apparently about one or two feet below) as the bed of the river in the most shallow parts; consequently, a vessel which could not pass over the former at high water, could certainly not pass over the latter. This is, of course, undeniable. But this argument is weak in this respect. Should the river Hooghly ever be improved,—and who that has studied what has been done on the Clyde, the Tweed, the Danube, and the Mississippi, will venture to say that it will not be,—should the Hooghly be improved, our grandchildren may find that the ships of their day, which may be as much larger than ours are than those of our fathers, or indeed ships no larger than those which now frequent the Hooghly, will succeed in passing up the deepened river, but will be unable to pass into the docks until the spring tides give them sufficient depth over the sills. But it may be said that I look too far ahead. Let us examine the question on the facts of to-day.

Some time last year I worked out these facts with reference to the average of Hooghly tides:—

The tide rises the last foot up to—

H. W. L. in	1·2 hours,
penultimate foot	0·5 „
foot before that in	0·4 „
„ „	0·4 „

but the tide falls more slowly: thus—

The tide falls the first foot below—

H. W. L. in	1·2 hours.
next foot	0·7 „
„	0·8 „
„	0·6 „

These are averages, it should be remarked, and are not strictly true for any one tide; but, generally speaking, it is true to say that if the tide rises to, say, x feet above the sill, then it will remain, on the rising tide—

1·2 hours	above $(x-1)$ foot on the sill
1·7 „	„ $(x-2)$ „
2·1 „	„ $(x-3)$ „
2·5 „	„ $(x-4)$ „

or, stating the same thing in other words, if a ship draws x feet of water, she will have 1·2 hours in which she can enter or leave the dock if the sill be fixed at—

	$x+1$ foot below H. W. L.
1·7 hours if at	$x+2$ feet „
2·1 „	$x+3$ „
2·5 „	$x+4$ „

So that for every foot the sill of the entrances may be lowered, an extra half hour or so will be afforded for the entrance of ships of deep draught on the rising tide. But, taking the rising and falling tide together,—that is, if ships enter and leave the dock after the turn of the tide,—the difference in time due to every foot the sill is lowered amounts to about 1¼ hours.

It certainly seems to me that it would be wise, after what Mr. Rendel has said, and considering the great risks which must certainly attend docking or undocking on a falling tide, to fix the level of the entrance sills on the hypothesis that ships will only pass through the entrances on the rising tide. It would seem, indeed, from paragraph 27 of the Committee's report,* that they only intended to dock and undock on the rising tide. Mr. Bruce says (paragraph 16)† that there would always be 3 feet more water on the sills than the draught of any vessel which could pass the bad parts in the Hooghly. This means allowing one foot clearance only between the ship's keel and the sill that ships of the draught which could pass down the river on any given day during neap tides would only have 1·7 hours, or say 2 hours during which they could safely pass the entrances. This, it appears to me, is insufficient time. The Committee suppose (paragraph 40) that 864 vessels will use the docks every year; that is, an average of nearly five ships a day both entering and leaving. The number of ships entering and leaving the dock would, at certain times of the year, be considerably above the average, so that it may be assumed that at the busy time which is in the cold weather, when the neap tides are lowest, it may often occur that eight or even ten ships may demand to be passed at one tide. It would appear to me that it would be very desirable to lengthen the time during which the ships could pass by dropping the entrance sills at least to the level (16·00—datum) which Mr. Bruce himself contemplated at one time, if not to that proposed by Mr. Rendel (17·00—datum).

The latter level would practically double the time, on the rising tide, during which ships of deep draught could pass the entrances.

But there is, I think, another consideration with reference to this level of the entrance sills which is of no little importance. It is that of silt in the entrance channel; that is, the channel from the entrance to the river. The entrance channel of the Chitpore Lock is about 150 feet long. It silts up, at certain times, with incredible velocity. The entrance channel to the docks will inevitably do the same. Flushing from the basin will not completely remove this silt; but the lower the sills are, the lower will the bank of silt beyond them be: for the lower the sills the lower the tunnels, and the lower the tunnels the more efficient the scour. I believe that it will rarely be possible, even with the aid of dredgers, to keep the bank of silt in front of the outer sills down to the level of the sills during the months of November and

* See also paragraph 26 of Committee's report.

† Note on Mr. Rendel's Memorandum.

December. In those months the levels of high water fall rapidly, and it is then that ships will be hindered, unless the sills are kept as low as may be possible.

The bottom of the foundations of the entrance lock is shown on Mr. Bruce's plans as 26·00—datum. We put the foundation of the Chitpore Lock in dry at a depth of about 7·00 or 8·00—datum. We used no wells. No doubt the difficulties of getting down 20 feet below this would be very much greater than any we had to master at Chitpore; but I am of opinion that it would be perfectly possible to put the entrances 2 or 3 feet lower than Mr. Bruce shows on his drawings at no very extraordinary expense. I notice that in Mr. Wawn's design for the Diamond Harbour Dock, the entrance sills are 29 feet below H. T. neaps; that is, 4 feet lower in comparison than is proposed by Mr. Bruce at Kidderpore.

On the first point, then, I give my vote with Mr. Rendel, as far as the entrances are concerned. The basin must, of course, be carried to the same depth as the sills of the entrances; and it would be an advantage, as Mr. Rendel suggests, if it could be cut 2 feet deeper.

But Mr. Rendel goes further than this. He would sink the dock proper 7 feet deeper than is proposed, and the passage between the basin and the dock 5 feet deeper. Here I cannot agree with Mr. Rendel, and think that Mr. Bruce has quite established the superiority of his plan. Mr. Rendel would reduce the dock to a low-level one, chiefly because he objects to pumping. To these objections I will refer presently; but, accepting them as valid, the cost of the proposal is, as Mr. Bruce shows, against Mr. Rendel's proposal; and Mr. Rendel is, I think, greatly mistaken in thinking that there would be no great difficulty in getting down to the depths proposed. It would probably be much more difficult to work to the depths contemplated by Mr. Rendel in the dock proper than in the entrances. The soil is shown by the borings to be inferior, and experience corroborates this. I doubt if any estimate could be made, which would be at all reliable, of the extra cost involved by this proposal.

I now come to the second point, which is that pumping should be avoided. Mr. Rendel says: "If it is supposed that accumulations of mud in the docks will be avoided by pumping I think there will be disappointment." Any one who has had to deal with Hooghly silt knows that it deposits itself, up to a certain percentage of the quantity in the water, with great readiness. I have not got the figures by me; but, speaking from memory, I believe the experiments made some two years ago on the settling tanks of the Calcutta Water-works show that about 70 per cent. of the silt in the Hooghly water is deposited in the first 24 hours, and that, of the remainder, there is a considerable proportion which is not cleared from the water even by filtration. Last year I had a series of levels taken monthly of the Calcutta Canal inside the new Chitpore Lock. The silt was clearly registered in the first 400 yards or so; there was no trace of it half a mile away. In that case, however, the quantity of water admitted to the canal was greatly less than that which will be required for the Calcutta Docks; but it will be seen from Mr. Bruce's plans that the point from which it is proposed to pump the water from the canal to the docks is between 5 and 6 miles from the river. At this distance, even if the water were always flowing, a vast proportion of the silt would undoubtedly be deposited; but Mr. Rendel is mistaken in supposing that there would be a constant flow in the canal. The pumps would work intermittently in the first place, and, as it is intended to keep the water surface of the canal very considerably above low-water level, the canal would be fed by tidal action, which would again offer the silt an opportunity of depositing when the water was at rest. Further still, Mr. Bruce contemplates a velocity of only ·076 feet per second in the canal when the pumps are working, which is practically still water as far as silt is concerned when that silt is brought in from a river flowing with a velocity of, say, 3 or 4 feet a second or more. On ordinary occasions, the water which entered from the river would remain in the canal five or six days before it would be pumped into the docks, even supposing that all the water pumped into the docks did come from the river.

But strong—irresistible—I think, as Mr. Bruce's case is, in reply to Mr. Rendel's contention that pumping would not diminish silt, he has by no means made the most of it. The project which now lies before the Government of Bengal for canalising Tolly's Nullah was prepared by myself. It is that canalised nullah which is to be the canal which will supply the docks with water. I am intimately acquainted with all the circumstances of this proposed canal (existing nullah). Now, as a matter of fact, the canal has a large catchment area: it drains a large tract of rice-fields (something like 70 square miles—I write from memory), and one result of this will be that during those months of the year when the silt in the Hooghly is really formidable, the water which will be in the canal will be almost entirely rain-water from the rice-fields, as free from silt almost as the filtered water-supply of Calcutta.

On every count, then, I think Mr. Rendel is out of court on the point of the pumps carrying silt to the docks.

But, putting that aside, Mr. Rendel contends that the silt must come either into the dock or the canal, and will have to be dredged in any case, and that it may as well be dredged from the dock as from the canal. This is not, as I have shown, strictly true (but Mr. Rendel could not have been aware of the fact); for in the worst months the water will not come from the river as a rule. But, even if it did, Mr. Bruce has completely answered Mr. Rendel; for no one can think that it will cost half the sum to dredge from the canal that it would from the much deeper water of the docks.

If Mr. Rendel's proposal to lower the docks 7 feet, and to feed them from the river direct through the entrances, is adopted, there is, in my opinion, no doubt that the difficulties which will in any case have to be encountered in the entrance channels will be increased, that it is by no means improbable that the easy working of the gates will be prejudiced, and that large dredgers will be necessary. These would be a nuisance in themselves, and would interfere with the traffic.

There is another argument in favour of Mr. Bruce's plan of pumping. It is that this plan will preserve the purity of the water in the dock. The Calcutta Canal has a lock at each extremity—one on the Hooghly, another on the Sunderbun channels. It is therefore possible to admit water at one end and let it out at the other; but there is a loop and a chord line on the canal between the two locks; this makes it particularly difficult to change the water in the centre of the loop. Last year I had great difficulty in keeping the water in this loop decently clean: indeed I failed, although I frequently changed more than half the water; the water in one particular *cul-de-sac*, taking off from the loop of the canal (in which practically I could not change the water at all), became exceedingly foul. The circumstances of the canal and the proposed docks are not parallel, for some drainage is still permitted to flow into the canal. No doubt the dock will, however it be fed, be always cleaner than the canal was last year; but one of the causes which defiles the canal will be very potent to defile the docks; that is, the habit of native boatmen to use the rudders of their boats or a temporary stage instead of a latrine. We have latrines all along the Calcutta Canal, canal police are stationed along the banks, and every boat is moored alongside the bank, but we fail to stop the practice I refer to. In the docks it will be much more difficult to do so, as many of the cargo boats, and all the ships which lie at the moorings in the centre of the dock (see paragraph 18 of Mr. Bruce's reply), will be a considerable distance from shore; and I am convinced that it will be found practically impossible to carry out the regulations contemplated in paragraph 32 of the Committee's report, which propose to lock up all closets and urinals, and compel the large floating population to use the latrines on shore. I do not think a policeman on every native boat would compel the people to go on shore; indeed, many of them could not, as they have no boats.

If the dock be fed as Mr. Bruce proposes, all the water in the dock can be changed; if it be fed as Mr. Rendel proposes, there will be a large proportion of the water which will never be changed.

I would here venture to make a suggestion of my own; this is, that the water which is pumped into the dock should be discharged at the extremity of the dock furthest from the river, and not into the centre of the dock, as is apparently proposed by Mr. Bruce.

I have already referred to the third modification proposed by Mr. Rendel, that the docks should be fed from the river direct. This plan would be more expensive, more difficult to execute, and less advantageous in every way than the plan proposed by Mr. Bruce.

As to the fourth proposal, that the width of the dock should be reduced to 450 feet, I have no experience, and can give no opinion of any value. The extra width proposed by Mr. Bruce would not add very greatly to the cost. The extra expense is represented by the cost of removing 150 feet of spoil in the centre of the dock, the value of this amount of land, and the cost of 150 feet of quay-wall at each end of the dock. The Victoria Extension Dock in London is 490 feet wide, the Millwall Dock is 350 feet.

Mr. Rendel's fifth proposal is that the design of the basin should be altered. Mr. Rendel proposes this, it would appear, with some reference to his opinion that the lower entrance "will not be of use in proportion to its cost." It seems to me that Mr. Bruce answers this point completely. Mr. Rendel seems to be unaware of the fact, which is all-important with reference to the point in question, that the current in the Hooghly does not turn for a considerable number of days in the rains. The stream always flows to the sea, although the level of the water rises and falls as usual. Mr. Bruce quotes the highest authorities in India in favour of the form of basin and entrance he proposes. This is a question more for captains of ships and pilots to decide than for engineers.

On the sixth point raised by Mr. Rendel I have little to say, and no experience. Mr. Bruce appears to me to give good reasons for his design.

The seventh proposition which Mr. Rendel makes is that the proposed foundations of the dock walls are insufficiently deep, and that they ought to be carried down 10 or 12 feet below the bottom of the dock. Mr. Bruce admits that this may be necessary in places, but quotes the Chitpore Lock as a precedent to the contrary. I am myself very much disposed to think that Mr. Rendel is right. Certainly, the Chitpore Lock is no precedent at all. There the lock walls were about 23 or 24 feet high above the floor. The dock walls are 36 feet above the bed of the dock. In the Chitpore Lock there is a masonry floor some 6 feet thick or more, which, of course, is a most powerful support to the walls, and effectually prevents them from sliding on the mud on which they are founded. The dock walls will have no such support. I see Mr. Wawn, in his design for the Diamond Harbour Docks, took special precautions against this, which are not taken by Mr. Bruce. In the construction of the Chitpore Lock our difficulty was that the foundations were frequently "blown up" by the pressure of earth at the sides. On more than one occasion pieces of the foundation of the side-walls weighing many tons, were pushed up in the air several feet by this pressure. We overcame the difficulty by laying pieces of the floor across from side to side, here and there, like the bars of a gridiron, to support the slopes, and we then got in the intermediate pieces. To some extent our difficulties at Chitpore were caused by confined space. This will not be the case at the docks; but then the foundations of the dock walls will be deeper than the Chitpore Lock (at least 7 or 8 feet). The borings seem to show that there may be a good deal of "sandy silt" below the dock walls. If there is any great extent of this, I agree with Mr. Rendel in thinking that there may be danger to walls founded only 5 feet below the dock bed, and that considerably greater expense may be incurred in the foundations than is provided for in the estimate. Mr. Bruce hopes that "the allowance for contingencies" may cover any excess in this direction. I greatly doubt it. This question of the dock walls merits the most careful consideration. It will be found, on investigation, that the pressure on the base of the wall as now designed is far from equal; that is, if the natural slope of the soil is taken as 3 to 1. There are several instances on record of dock walls founded more than 5 feet deep failing by sliding.*

It seems strange to me that Mr. Rendel should think that the walls will fail "after, if not before," the water is let into the dock. If the walls stand being backed up to the quay level on the soil shown in the borings, they will, I think, not fail afterwards. The water is a support, and will tend to prevent the cause of failure which Mr. Rendel anticipates. It may possibly be found best to leave the walls unbacked until the water is admitted, or to relieve the pressure on the back of the walls by a timber flooring.

Mr. Rendel suggests that a smaller scheme might be sufficient for the present. On this the Port Commissioners are presumably the best judges, and they do not appear to think so. But they, of course, recommended the present scheme on the basis of the estimates before them. These estimates Mr. Rendel evidently considers insufficient, and if Mr. Rendel's suggestions are adopted, Mr. Bruce has shown that the cost will be considerably enhanced. Of this there is, I think, no doubt.

As regards the estimates for the designs as they stand, I confess to great misgivings as to their sufficiency. But it is always so easy to say this; and one is, perhaps, tempted to say it, as experience has so often shown that it is a safe guess. I have, however, some grounds, at any rate, for thinking that the estimates are low. I prepared last year not only the project for the canalisation of Tolly's Nullah, which I have referred to above, but the project for the canal, referred to in paragraph 29 of the report of the Port Commissioners, which is proposed to connect the Calcutta canals with the docks. Both these projects are now with the Government of Bengal. In the course of the preparation of these projects, I had to consider, in several ways, the dock project and its estimates. I remember that the rates provided for the land in the dock estimates were very greatly below the rates supplied to me by the Collector of the district for similar land which was necessary for my projects. No provision appears to be made in the estimates for the cost of the Dockyard land. The cost per mile of the canal, which is estimated in estimate No. 6 of the dock estimate, is very greatly below the estimate which I worked out, in considerable detail, for the canal to connect the Calcutta Canal and the docks. In estimate No. 6, Mr. Bruce allows only 2¼ lakhs for the boat lock which is to admit nearly all native boats and cargo boats into the docks. This sum I take to be much too little. It would not, I feel confident, provide a lock of sufficient capacity to pass the traffic. The Dhappa Lock, at the east end of the Calcutta Canal, which has a smaller lift than is necessary for Mr. Bruce's boat lock, cost (I write from memory) 4½ or 5 lakhs;

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* See Vol. LXV of P. Inst. of C. E.

the Chitpore Lock, which is somewhat larger than the one in question need be, but which is more properly comparable with it, cost (excluding land) about 6¾ lakhs. There were several other items in the more detailed estimates which were appended to the copy of the report which was given to me (but which, I see, are not in the copies sent to the Government of India), concerning which it appeared to me doubts were justifiable. It is generally admitted in Calcutta that rates must rise when these great works are put in hand. Mr. Bruce, in paragraph 22 of his "reply," says that R36 will be sufficient to cover cost of masonry and pumping. Our masonry at Chitpore cost about R33 taken all round, without pumping. Mr. Bruce's estimate of R36 may be sufficient, but it is certainly a close one. Again, Mr. Rendel says that 15 per cent. is quite little enough for "contingencies" on a work of this nature. Colonel Trevor has shown in his note of 16th October 1883, that if the capital is raised half-yearly at four per cent., the (compound) "interest under construction," chargeable to capital, will increase that capital by 12 per cent. if the work takes five years to complete. Charges for "tools and plant" which, as pointed out by the Government of Bengal, are omitted from the estimate, will certainly not be provided for less than 2½ or 3 per cent. "Establishment" can hardly be taken at less than 7½ per cent., even on a work of this nature. Mr. Rendel thinks 10 per cent. is insufficient. These percentages aggregate 37 per cent.; but, even with the addition made by Bengal, only 20 per cent. has been allowed for in the total of 265 lakhs, which is taken as the total cost of the new docks.

I have, I see, omitted to refer to one point of importance. Mr. Rendel says that the loss by leakage, waste, levelling and lockage will be far greater than any estimate. Mr. Bruce has provided pumping machinery competent to raise the water surface in the dock four feet in 24 hours (paragraph 17 of "reply"). Mr. Rendel cannot possibly suppose that lockage, levelling and leakage of the gates and sluices would consume a quarter of this. He must, I think, assume that there will be great percolation from the high-level dock. In the Workingham Docks it was found that the loss was at first as much as 2 and 3 vertical feet between tides; but this soon "took up," and was reduced to 5 or 6 inches. There is, I think, no doubt whatever that the Calcutta Docks, although at first there may be some loss by percolation, will soon "take up" completely, and the leakage will be entirely confined to that through the gates and sluices. The Hooghly silt, which can be specially admitted to the dock, if necessary, would soon staunch a bed of sand.

Page 90, Vol. IV, P. Inst. C. E.

The 14th April 1884. R. B. BUCKLEY.

Note on objections raised by Mr. Rendel to proposed design for Kidderpore Docks, Calcutta.

Having carefully considered the description of the proposed dock and of the arrangements or working, feeding, &c., given in paragraphs 21 to 35 of the Committee's report, also Mr. Rendel's memorandum, Mr. Duff Bruce's reply to Mr. Rendel's objections, and an excellent note on the subject by Mr. Buckley, we have arrived at the following conclusions:—

1. That deepening the entrances to the tidal basin from the river to 16 feet below datum, as originally contemplated and provided for in the estimate,* should be *obligatory*. We are of opinion that the additional time which will thus be obtained for passing vessels in and out of the dock will be a practical advantage well worth attaining, and we do not consider that the solitary reason urged against the deepening, that vessels cannot proceed to sea during neap tides if drawing 22 feet or more of water, should be allowed to weigh against those in support of the improvement. Such vessels ought, in our opinion, to lie at moorings in the river until they can go to sea. The foundations of the retaining walls of the basin should be taken down to such a depth as to admit of dredging out the bed to the extra depth of 2 feet, recommended by Mr. Rendel, if found necessary.

* See Mr. Bruce's reply on page .

2. We are decidedly of opinion that the proposed method of feeding the docks with water by pumping must be maintained for two reasons:—

(*a*) to avoid obstruction of basin and dock entrances by silt, and
(*b*) on sanitary grounds.

We consider that the reasons given by Mr. Bruce, and the facts regarding the deposit of silt in the entrances of channels leading out of the river and the supply of Tolly's Nullah with comparatively clear water during the rains, stated in Mr. Buckley's note, are conclusive in favour of supply by pumping in preference to direct supply from the river. Further, we are strongly of opinion that, take what precautions we may, the water in the docks will become extremely foul if not frequently changed. It is stated in the Committee's report (paragraph 32) that all water-closets and urinals on board ships lying in dock will be kept locked and properly secured; but we do not see how the "fore chains" of the ships can be padlocked, or how the crews of native boats lying in the docks can be prevented from fouling the water at night. We strongly support Mr. Buckley's recommendation that the pumping station be shifted to the extreme end of No. 2 Dock furthest from the river.

We have considered the question of supplying the docks by gravitation, but, after due enquiry, find that this is not feasible within reasonable limits of cost.

3. We strongly support the recommendation that the width of the dock should be reduced from 600 to 450 feet.

We do not see any necessity for keeping all sea-going vessels in dock until they are able to proceed down the river, and consider that a certain proportion might very well lie outside at moorings while waiting either for cargoes or for water sufficient to admit of their leaving the river. Indeed, from a sanitary and business point of view, it seems to us especially unadvisable to crowd the docks with shipping, which would further increase the risk of loss by fire. Again, the smaller the quantity of the water in the dock, the greater the change produced by a given volume of water passing through it, and the fresher will it be kept by the pumping.

Having regard to these considerations, and to the great weight necessarily attaching to Mr. Rendel's opinion, we consider that the reduction of width suggested by him should be adopted.

4. Remembering the extreme fluidity of the subsoil and the long distances over which marked differences of head may act in producing springs, we think that leakage from the dock into the boat canal would be materially reduced if the channel of the latter were terminated and locked into Dock No. 2 at the end furthest from the river instead of being carried parallel to its whole length.

5. We consider that the weight of authority adduced in support of Mr. Bruce's design for the basin and entrances fully justifies its retention, and the arguments in favour of retaining the graving docks in the position proposed by him seem to us perfectly valid.

6. We are decidedly of opinion that Mr. Rendel's suggestions in respect of the depth of the well foundations of the dock and basin walls should be adopted. The facts given in Mr. Buckley's note regarding the Chitpore Lock show how treacherous the subsoil in the neighbourhood of Calcutta is, while the borings at site of the proposed docks show that nothing but sandy silt with a little clay may be expected over the greater portion of the foundation area. The foundations will most probably be on wells, which depend largely on frictional resistance for their stability, and a depth of 4 or 5 feet below the bed of dock does not seem to us sufficient to resist the geat detrusive force which will be exerted on the bottom of the dock retaining wall, especially during construction.

The numerous failures by sliding of massive dock walls in England, when founded on soft mud and silt, all point to the necessity of great caution in this respect at Kidderpore.

We have no personal experience of the character of the soil in the immediate locality; but, remembering the nature of the subsoil in other places near Calcutta, we fear that the frictional resistance will be extremely small, and it is not improbable that even a greater depth of foundation than that recommended by Mr. Rendel may be found necessary. We are further of opinion that the dock and basin walls should consist either of solid masonry or concrete to such a depth as will prevent the blowing in of soil approaching to the nature of quicksand when the pressure on both sides of the wall may not be in equilibrium, as we consider that wells are quite inadequate to withstand any such action. Special precautions will be necessary in this respect in the case of the walls between the dock proper and the basin as it appears from paragraph 27 of the report that the level of the water in the dock will frequently be for a considerable time from 8 to 9 feet above that in the basin.

7. Having regard to the rates and cost of work quoted by Mr. Buckley and to the nature of the work to be done at Kidderpore, we think that it would be safe to allow 25 per cent. on the works estimate for contingencies, tools, and plant, and interest on outlay during construction, in estimating the probable cost of the completed work.

GUILFORD L. MOLESWORTH.
HENRY A. BROWNLOW.

The 28th April 1884.

Report of the Proceedings of the Dock Committee at Meetings held on the 3rd and 14th of May and 2nd and 3rd June 1884.

PRESENT:

H. A. Cockerell, Esq., C.S.I
W. Duff Bruce, Esq.
J. J. J. Keswick, Esq.
The Hon. R. Miller.
R. Steel, Esq.

The following papers have been submitted to and considered by the Committee, and copies are appended and numbered as follows:—

(1) Letter No. 73T.—M.P.I. of the Government of Bengal, Public Works Department, dated 22nd October 1883, forwarding to the Government of India
(2) Note by Colonel Heywood, Officiating Chief Engineer to the Government of Bengal, on the report of the Calcutta Dock Committee.
(3) Despatch from the Government of India, No. 57P.W., dated 30th October 1883, to the Secretary of State, submitting the Dock Committee's report for His Lordship's consideration.
(4) Letter No. 54T.—M.L.I. of the Government of Bengal, Public Works Department, dated 22nd April 1884, forwarding
(5) Letter No. 142M. of the Government of India, Public Works Department, dated 9th April 1884, forwarding
(6) Despatch from His Lordship the Secretary of State, No. 13P.W., dated 6th March 1884, on the report of the Docks Committee.
(7) Enclosures of the foregoing despatch, including a memorandum by Mr. A. M. Rendel, containing his professional opinion upon the proposed dock scheme.
(8) Remarks by Mr. W. Duff Bruce, Vice-Chairman of the Commissioners, replying in detail to the several points raised in Mr. Rendel's memorandum.
(9) Letter No. 139T.—M.P.I. of the Government of Bengal, Public Works Department, dated 9th May 1884, forwarding
(10) Letter No. 176M. of the Government of India, Public Works Department, dated 30th April 1884, forwarding
(11) Note by Mr. R. B. Buckley, Under-Secretary to Government of India, Public Works Department, upon the objections raised by Mr. Rendel to the proposed dock scheme.
(12) Joint opinion of Colonel Brownlow and Mr. Molesworth on the original proposal in connection with the engineering features of the dock scheme, Mr. Rendel's objections, and Mr. Bruce's replies.

2. The whole of the above papers having been carefully considered by the Committee, they now desire to record their opinion upon the several questions raised therein.

3. The objections raised by Mr. Rendel to the engineering features of the scheme and Mr. Bruce's reply have been very fully dealt with in Mr. Buckley's note, and the conclusions arrived at by the Government of India are summarised in the note by Colonel Brownlow and Mr. Molesworth. These conclusions the Committee proceed to take up in their order:—

(1) That deepening the entrances to tidal basin from the river to 16 feet below datum, as originally contemplated and provided for in the estimate, should be made obligatory.

4. This decision the Committee recommend the Commissioners to accept. By keeping the coping level of the wall at 24 feet over datum instead of 26 feet, there will be no increase in the brickwork, and only a small additional increase for well-sinking and earthwork. It is always an advantage to keep the sill as low as possible, and although, as pointed out in paragraph 25 of the original report by the Dock Committee, there is no absolute necessity, taking all the circumstances connected with the river into consideration, to keep the sill lower than 14 feet below datum, still, in deference to the strong opinion expressed on this point by Mr. Rendel and the Government of India, the Committee recommend that the decision of Government on this point should be accepted.

(2) That the proposed method of feeding the docks with water by pumping must be maintained for two reasons—
  (*a*) to avoid obstruction of basins and dock entrances by silt, and
  (*b*) on sanitary grounds.

But that the pumping station should be shifted from the position shown on the original plan to the end of No. 2 Dock furthest from the river.

5. In this decision the Government of India supports the recommendation of the Dock Committee that the dock should be constructed as a high-level dock, and the level of the water maintained by pumping. In the original design the pumping station is shown at end of No. 2 Dock, closest to the river. This was done to keep the pumping engine and the engines for working the hydraulic machinery together, so that one establishment could work both. The position selected being about the centre of the docks is that best suited for the hydraulic machinery, but it will no doubt be an advantage, from a sanitary point of view, to feed the docks with water at the end furthest from the river instead of at the centre of the dock. By supplying the water to the docks at the extreme end, the whole body of water in the docks will move forward towards the entrances; whereas when fed at the centre, the water at the upper end of the dock would not be so readily changed. The Committee would recommend the Commissioners to accept this modification as far as regards the site of the pumping station. A revised plan showing the new position of the pumping station is submitted with this report. It will be seen that advantage is taken of this change to place the boat lock and pumping station on the canal instead of between the canal and the dock. In the original plan it was proposed to keep the boat dock at the same level as the water in Tolly's Nullah,—that is, from 6 to 8 feet lower than in the dock. Mr. Molesworth and Colonel Brownlow, however, consider this objectionable and likely to tend to leakage from the dock into the canal where the canal runs parallel to Dock No. 2, and they recommend that the boat canal should terminate at the end of the Dock No. 2, furthest from the river. It would be very inconvenient to terminate the boat canal in this position, or in fact anywhere short of the position shown on the original plans. In the original design the boat canal is carried up to the end of the salt golahs, so as to enable boats to load from the salt golahs without going into the dock. At least 20,000 tons of salt will be taken away every month by country boats, and if the boat canal is not carried up to the salt golahs, it will be necessary for the whole of these boats to go into the dock to load. If boats can lie in the canal and load from the golahs, only boats taking salt direct from the ships will have to go into dock. It would also be very inconvenient to have boats loading from the salt golahs lying in the dock and taking up valuable quay space which could be used by sea-going vessels. For these reasons it is, the Committee consider, necessary to carry the canal to the position shown in the original design. The objection raised to the section of the canal which runs parallel to Dock No. 2 will be met by keeping the water in it on the same level as the water in the dock. The lock will be placed on the canal below the end of Dock No. 2, furthest from the river, and communication between the boat canal and the main dock will be by an entrance at the end of Dock No. 2. A steady flow of water through the high-level boat canal will be maintained by the hydraulic pumping engines which are to remain in the position originally proposed at the upper end of the canal. All water required for the cranes and boilers will be taken from the boat canal, and the condensing water will be pumped from the boat canal and discharged into the docks. With the large pumping engines discharging into the lower end of Dock No. 2, and the hydraulic engines pumping from the upper end of the boat canal, a steady and constant flow of water will be maintained through the canals and dock.

6. These alterations in the arrangement of the canal and boat entrance to the dock rendered it necessary to revise the estimate for the boat canal, and a new estimate has been prepared for this part of the scheme. The design of the lock has also been changed so as to make it suitable for passing through a large number of boats or only three or four boats at a time. There will be a large basin, 250 feet by 120, and a chamber, 100 feet by 40. This necessitates three pair of gates instead of two as provided in the original estimates. A design for this lock has now been prepared, and the estimate taken out in detail. The cost of the lock will be R4,25,000, and of the boat canal R10,81,446, as compared with R8,89,706 in the original estimates. In comparing the cost of the lock in this project with the cost of the lock constructed at Dhappa, it must not be overlooked that stone was very largely used at Dhappa, whereas this lock will be constructed of brickwork throughout, and stone used only in the quoins and coping.

(3) That the width of the dock should be reduced from 600 feet to 450 feet. There is no necessity for keeping all sea-going vessels in dock until they are ready to proceed to sea, and a certain proportion might lie outside at moorings while waiting for cargo or for tides to enable them to leave the river. That from a sanitary and business point of view it is unadvisable to crowd the dock with shipping, which would increase the risk of loss by fire; and that the smaller the quantity of the water in the dock, the greater the change produced by a given volume of water passing through it, and the fresher it will be kept by pumping.

7. The necessity for maintaining the dimensions of the dock as originally designed has been discussed by Mr. Bruce in his reply to Mr. Rendel, and the reasons given by him against reducing the width have not, the Committee submit, received sufficient consideration by the Government of India. There is no dock in England in which the boat traffic bears any proportion to the enormous number of boats that ply to and from Calcutta, and consequently no port at which the experience hitherto gained would be a safe guide in determining the accommodation required for this traffic in a port like Calcutta. There are about 5,900 lighters and native cargo boats licensed to ply with cargo in the port of Calcutta. The docks will no doubt do away with the nesessity for a very large number of these boats, but still a very large traffic will be done in cargo boats, and it may be assumed that when the docks are completed and most sea-going vessels use the dock, there will never be less than 500 or 600 cargo boats in the dock. These alone would occupy a space of about 100 feet in width for the whole length of dock. A line of vessels alongside the quays on each side and another in stage berth, would occupy about another 200 feet, so that between vessels and cargo boats it would not be safe to assume that less than 300 feet of the width of the dock will be occupied. For the movement of vessels up and down the dock, the Harbour Master, whom the Committee have examined, considers that a clear passage of at least 200 feet should be maintained, so that the least width that could be adopted would be 500 feet.

8. But in considering this question the probable necessities of the future should not be lost sight of. What is adapted for the requirements of the present day may not be suitable ten years hence. The average tonnage of the vessels that entered Calcutta in 1870-71 and in 1883-84 was as follows :—

	Number.	Gross tonnage.	Average tonnage.
1870-71.			
Steamers	259	327,960	1,266
Sailing vessels	672	666,431	991
Total	931	994,391	1,067
1883-84.			
Steamers	603	1,371 802	2,275
Sailing vessels	482	6,05,567	1,256
Total	1,085	1,977,369	1,822

The length and draft of vessels seem to have arrived at a maximum for the present. But the beam is increasing, and if the average tonnage increases during the next twenty years in anything like the proportion it has advanced at during the last ten years, the beam of vessels to be accommodated in these docks will be much beyond the average beam of vessels of the present day. The width of 600 feet proposed is only 100 feet more than the Committee consider absolutely necessary for the requirements of the present, and considering the small amount, comparatively with the whole cost, that this extra hundred feet adds to the estimate, the Committee are decidedly of opinion that the original width should be maintained. In a climate like that of Calcutta it is most desirable that as much space as possible should be given to vessels in the dock, and that they should not be crowded together in such a way as to prevent free and perfect ventilation. It would of course be possible to prevent overcrowding by limiting the number of vessels that were allowed to go into dock, but it would be very inexpedient to do so, and the dimensions of the dock were fixed so as to enable all the vessels trading to this port to use the dock if they wished to do so without overcrowding. In the Prince's Dock at Bombay the Committee find that the area of water space to quay space is in the proportion of 218 square feet of water area to 1 foot of quay space. In the Calcutta docks as designed, the water space to quay space is in the proportion of 255 feet to 1 foot; but if the breadth is reduced to 450 feet, the proportion will then be 198 feet of water area to each foot of quay space. In Bombay the boat traffic is very small compared with that of Calcutta, and if a water area in porportion to quay space of 218 to 1 is found necessary in Bombay, the proportion for Calcutta should not be less than that originally designed. The proposal to reduce the with of the dock " because the smaller the quantity of water in the dock, the greater would be the change produced by a given volume of water passing through it and the fresher it will be kept by pumping," might be met by the fact that the larger the quantity of water in the dock, the less likely is it to become foul from a given quantity of impure matter.

9. After giving this matter the fullest consideration, the Committee are strongly of opinion that the breadth of 600 feet should be maintained, and that the saving effected by

adopting the lesser width would not compensate for the greater advantages secured by adhering to the original dimensions. But if the Government of India, after giving full consideration to the reasons now urged, are still decided that the width should be reduced, the Committee recommend that under no circumstances should the width of the dock be less than 500 feet. A reduction in width to 500 feet represents a saving as shown in the estimates now submitted of R8,97,391.

(4) That the canal should be terminated at the end of No. 2 Dock furthest from the river, instead of being carried parallel to the dock to the end close to the river, so as to avoid any risk of leakage from the dock into the boat canal.

10. The Committee have already explained the objections (paragraphs 5 and 6) to this proposal to reduce the length of the boat canal, and have altered the plans so as to meet the objection here raised.

(5) That Mr. Bruce's design for the entrances and tidal basin should be retained, and the graving docks kept in the position in which he proposed to place them.

11. This decision leaves the plans of the entrances, tidal basin, and dry dock as originally proposed.

(6) That Mr. Rendel's suggestion to carry the foundation of the dock and basin walls to a depth of at least 10 feet below the bottom of the dock and basin, instead of 5 feet as proposed in the original design, should be adopted, and that the dock and basin walls should consist of either solid masonry or concrete to such a depth as will prevent the blowing in of soil approaching to the nature of quicksand when the pressure on both sides of the wall may not be in equilibrium. Special precautions to be taken in this respect in the case of the walls between the dock proper and the basin.

12. In the revised estimates herewith submitted, provision has been made for founding the dock and basin walls 10 feet below the bed of the dock and basin. Detail plans of the walls showing how they are to be constructed are also submitted. It will be seen that they are to be founded on square blocks and not on circular wells; the blocks will be sunk close together and finished at 8 feet below datum. Above this level the wall will be carried up solid. Behind the wall a teak pile 12″ × 8″ will be driven to cover the openings between the inner wells, and where the spaces between the wells make it possible to do so, the mud will be scoured out and cement grouting run in to fill up the interstices. The excavation for the dock will be carried down dry to the level of the top of the wells, and after the quay-walls have been built up, to the level of about 5 feet above datum, water will be admitted into the excavation up to the level of 2 feet above datum. This will give 5 feet of water in the excavation, in which to work hydraulic dredgers and barges, and the remaining 11 feet will then be dredged out. The hydraulic dredgers will be made to work to 16 feet, so that they will just finish the work at the exact depth required. By this arrangement the wells will have the pressure of 16 feet of water to support them before the earth in front is removed, and the chances of any slip occurring or of the bottom blowing up will by adopting this arrangement be very small indeed. The backing behind the walls will be composed of river silt put in in layers, one foot six inches thick, thoroughly watered and rammed, and when well consolidated, will be quite impervious to water. With these precautions and the wells carried down to 10, feet below the bottom of the dock, there should be no chance of the dock walls being thrust forward.

(7) That 25 per cent. in the works estimate should be allowed for contingencies, tools and plant, establishment and interest on outlay during construction.

13. In Mr. Buckley's note he says that "Colonel Trevor has shown in his note of the 16th October 1883 that if the capital is raised half-yearly at 4 per cent., the interest during construction chargeable to capital will be 12 per cent. if the work take five years to complete." The Committee are of opinion that if interest on capital during construction is to be a charge on the works, 25 per cent. for all contingencies and to cover interest will hardly be sufficient.

To be quite safe, we should allow—

1. Contingencies on works	. . . .	10 per cent.
2. Tools and plant	. . . .	3 „
3. Establishments	. . . .	5 „
4. Interest during construction, say	. . . .	12 „
Total	.	30 per cent.

14. With reference to the question of interest charges during the time the works are in progress, the Secretary of State, in paragraph 11 of his despatch, suggests that the necessary advances of interest during construction should be charged against Provincial revenues, the Local Government receiving from the Government of India such special additional grant as would be required to meet this charge. In return for this assistance the Local Government would fix such a scale of rates when the docks are hereafter at work as to meet not only interest charges on the capital debt, but also to pay interest upon the amount advanced by the Local Government, and eventually to liquidate out of Revenue the whole of the advances made for interest while the works are under construction. The estimate should not in this view make any provision for interest, and deducting this charge, 18 per cent. will be sufficient for contingencies on the work, cost of establishment, and tools and plant.

15. As regards the provision for establishment, the Committee think 5 per cent. will be found sufficient. Mr. Rendel in his note suggests that the work should be done departmentally, and this recommendation the Committee entirely support. Contracts will be entered into for the supply of all material, but the construction of the works should be retained in the hands of the Commissioners' own Engineers. A larger establishment will, however, be necessary under this arrangement than if the work were being carried out by a large contractor. When work is given out by contract, all that it is necessary for the Engineer to do is to supply drawings and specifications, see that they are properly worked to, and that good materials are used in the construction of the work. But if the departmental system is adopted, then the Engineer in charge must make all his own arrangements for the supply of material and labour, and, in addition to drawing out plans and specifications, do all the work which on the contract system would be done by the contractors. The departmental system therefore, requires a very much larger establishment than the contract system, but, for a work such as the docks, will be the cheapest, as no contractor could undertake such a work without putting on a very large margin for risk, and to cover the cost of the large establishment he would be obliged to employ to properly supervise the work. A contractor, however has one great advantage in carrying out such works. He can employ whatever men he sees are necessary to carry on his work, without consulting any one, and he has full power to dismiss them whenever he finds he does not want them, or they are not giving satisfaction. Such power the Committee consider is absolutely necessary in carrying on a large work, and if it is decided to construct the docks departmentally, the Commissioners should have it clearly understood that they have full power to employ as many men as they consider necessary, and to dismiss men who do not give satisfaction or are not wanted. None of the men employed on this establishment would be on the Commissioners' regular staff; they would be employed to carry out the work and would be charged direct to the work. Assuming, then, that it is decided to carry out the work departmentally, the Committee are of opinion that the following will be found sufficient:—

	R		R
One Superintending Engineer	1,600	=	1,600
Two Resident Engineers	1,200	=	2,400
Two Assistant Engineers	600	=	1,200
Two ditto	500	=	1,000
Five clerks of works, at	400	=	2,000
Five ditto	300	=	1,500
Ten subordinates, &c.	200	=	2,000
Clerks and draftsmen			1,000
Office and contingencies			1,000
			13,600

or per annum R1,63,200. If the works take five years to complete, the expenditure on establishment would be R8,16,000, while the amount (at 5 per cent.) provided in the estimate amounts to R11,66,597. This, however, must only be taken as an approximate estimate The Commissioners should not be bound by the numbers or pay, but have full power to increase or reduce, and to fill up vacancies without any reference to Government.

16. As regards the rates, we are satisfied that those at which the work is taken in the estimate will prove ample. Mr. Buckley in his note mentions the fact that the rate for the Chitpore Lock was R33 against R36, the rate taken in the dock estimates. The rate of R33 was the rate paid to the contractors, Messrs. Burn & Co., and out of which they had to get their profit and pay for their establishments. The Committee have appended to the revised estimates (page) an abstract of the rates for earthwork, brickwork, and concretee giving the details of cost of each item, from which it will be seen that the rates taken in the estimates are amply sufficient for the work.

17. In paragraph 16 of the Secretary of State's despatch he remarks :—

> "I observe that in paragraph 11 of your letter, approval is expressed of the connection of the docks with the jetties in Calcutta by a tramway skirting the river bank, as well as by a railway from Sealdah, passing outside of the town. As such a tramway must pass close under Fort William, and between the river and the most frequented drives in Calcutta, it could not fail to be a source of much inconvenience to the public, and otherwise there appear to me very grave objections to its construction, which, moreover, could not be really requisite if the other railway connection is provided. I request that these points may have your earliest attention."

18. In paragraphs 38 and 39 of the Dock Committee's report the necessity for this connection is explained. The report says :—

> "It is proposed that the docks at Kidderpore shall be connected with the jetties and the inland vessels' wharves by an extension of the Commissioners' Tramway from Chandpaul Ghât direct along the river side to Kidderpore. It is an essential part of the scheme that this connection should be carried out. With the tramway connecting the docks at Kidderpore with the jetties, it will be an easy matter to convey goods to the warehouses now being built at the jetties, and it would be a matter of a little extra haulage to take tea from the proposed new tea warehouse at Armenian Ghât to the import dock at Kidderpore instead of to the jetties. In both cases the tea will have to be loaded into trucks to convey it from the tea warehouse to the wharf, but it would manifestly be very inconvenient to take tea to the docks without a direct tramway along the Strand Road."

19. Without a tramway along the river bank to connect the jetties and business quarter of the town direct with the dock, very great inconvenience would be experienced in working the dock. In fact, as pointed out by the Dock Committee, it is an essential part of the whole scheme that this connection should be sanctioned. Without it all goods going from warehouses in Calcutta to the docks or from the docks to private warehouses would, if sent by tramway, have to go by Chitpore and Sealdah, a detour of about 11½ miles, to get to the dock. It is quite certain that the Commissioners could not afford to take goods by this circuitous route to the warehouses at the jetties, and the result would be that goods for such warehouses would if no tramway is constructed, be brought in native carts from the docks to their warehouses as well as to other private warehouses in town. The Commissioners could not, however, trust to such a means of communication. The dock scheme would be incomplete without the tramway, and they trust that when the absolute necessity of this means of communication is explained to the Secretary of State, no further objections will be raised to its construction. There is now a passenger tramway, worked by locomotives, running across the maidan on the road between the corner of Dhurrumtollah and Kidderpore Bridge to the east of the Fort. This tramway causes no inconvenience to the Fort or military authorities, and there is no reason why a goods tramway on the road to the west should prove in any way more inconvenient; on the contrary, the goods tramway would be a very great convenience to the Commissariat and Ordnance Departments, and would place their warehouses at Hastings in direct communication with the docks, the jetties, and the whole railway system. It has several times been suggested that the Commissioners' tramway should be extended from Chandpaul Ghât, along the Strand Road, to the Commissariat and Ordnance godowns at Hastings, and the proposal has always been supported by the Commissariat and Ordnance Departments. For their traffic alone it would not have paid to lay down the extension, but now that the line can be used in connection with the docks, and is in fact absolutely necessary for the proper working of the docks, there is no reason why its construction should be any longer delayed.

20. In regard to the financial question, the original report recommending the dock scheme stated that in the opinion of the Committee it would be impossible for the Commissioners to raise in the local market the loan required for these works, as they recommended that Government should be asked to advance the necessary funds, as required, charging interest at 4 per cent. during the time the works are under construction, and that on completion of the docks the whole amount should be made a permanent debt bearing interest at 4½ per cent. The Committee pointed out that Government advanced the money spent in the construction of the Prince's Dock at Bombay on these terms, and expressed their opinion that the funds required for the Calcutta Docks should be advanced in the same way. The Port Commissioners, when adopting the report of the Dock Committee, passed the following resolution :—

> "That Government be informed that the Commissioners are prepared to carry out the works recommended by the Committee in accordance with the plans submitted provided Government will advance the necessary funds, charging interest at 4 per cent. during the progress of the works, and upon their completion allowing the loan to remain as a permanent debt bearing interest at 4½ per cent. per annum."

21. In submitting the scheme to the Government of India, the Government of Bengal left the consideration of the manner in which the necessary capital was to be provided entirely in the hands of the Supreme Government. In their despatch to the Secretary of State,

No. 57P.W., dated 30th October 1883, the Government of India, in paragraph 15, thus expressed their views upon this question :—

Assistance from Government.

"The Committee ask that Government should either (1) guarantee a loan to be raised by the Port Commissioners for the special purpose of the works, or (2) advance the funds as required, charging interest at 4 per cent. during construction and at 4½ per cent. subsequently, in accordance with the precedent of the Prince's Dock at Bombay.

"It may be admitted that the Imperial Government are very intimately concerned in the provision of suitable docks and other arrangements for facilitating exports. By next year the Eastern Bengal Railway will be in our hands. The East Indian, the Calcutta and South-Eastern, and the Bengal Northern Railways are State lines. In the "Bengal Central Railway" we are interested as guarantors. It may therefore be said that the whole railway communication on both sides of the river is practically our own, and that as owners of this property we are called on, in our own interest, to do something for the port, as Railway Companies in England do. The docks are also likely, as pointed out in the Committee's 70th paragraph, to contribute to a more economical and effective control of the salt trade.

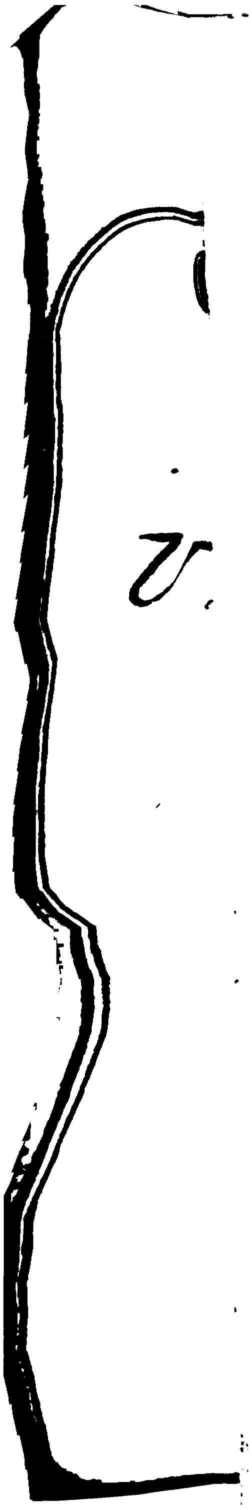
"On the other hand, it is unnecessary to dwell here on the grave objections to the grant of State aid or guarantees, with which your Lordship is fully conversant. We are therefore of opinion that the Port Commissioners, before inviting our assistance, should satisfy us that they have used every means in their power to obtain the money on their own resources, on terms which, in view of their assured income, are not too onerous, and that they have failed to do so. But if we find such assistance to be necessary, it should not be granted, except on the condition that the rates to be charged shall be fixed with our approval. It will be our object, having regard to the actual cost of the works and the condition of the trade of the port, from time to time, so to fix them as to put no unnecessary burden on trade, but to leave the Port Trust, after payment of the interest stipulated, a safe working margin, and no more."

22. In communicating his orders upon the scheme, His Lordship the Secretary of State, replying to the foregoing part of the Government of India's despatch, makes the following observations :—

"10. With regard to the question as to how the money should be raised, I agree with your Government that as a rule it is most desirable that public bodies entrusted with powers to expend money on certain local objects should depend on their own resources. If, therefore, you have good reason for believing that the Port Trust Commissioners would be able to raise the requisite amount on such reasonable terms as would enable them to pay the interest and to give the advantages of the new works to the commercial community at moderate charges, I would support your view that they should be left to make their own financial arrangements without aid from the Government. But it appears to me that the doubts entertained by the Commissioners are well founded, and that they might not be able to raise sufficient capital, except on such terms as would entail a charge for interest which would, at all events at first, exceed the receipts, and which must therefore, if they are left to their own resources, be paid out of their borrowed capital, and so greatly add to the ultimate burden on their revenues. It may consequently be proper, considering the character of the project and the general and Imperial nterests concerned, as in the case of the docks at Bombay and the harbour of Madras, to give the Port Trust some financial assistance in carrying out the project. If this should prove to be the case, I consider that the aid of your Government will be better given by an arrangement similar to that carried out at Bombay for the purpose of enabling the Port Trust to acquire the foreshore properties, than by the direct grant of funds supplied by the State.

"11. There would be considerable objections to adding to the public ebt so large an amount as that likely to be required for these works, which I am of opinion should not be permitted to bring any ultimate charge on the general revenues. I therefore think that it will be the best plan to authorise the Port Trust, by a local Act, to raise the money required under the guarantee of the Government, but subject to the control of the Government of Bengal, and that any necessary advances of interest should be charged against the Provincial revenues, on the understanding that such additional grant should be made to the Bengal Government as may seem equitable to your Government in order to meet the interest charge which could not be properly borne at the outset by the revenues of the Port Trust. Complete power should be reserved to the Local Government to require the Trustees so to regulate the charges for the use of the docks, and otherwise to apply their available income, as to provide a reasonable contribution towards the discharge of the interest on the Dock loan from time to time as it becomes due, and eventually to liquidate the whole sum that may be advanced."

23. When forwarding these orders of the Secretary of State for the consideration of the Commissioners, it was stated by the Government of India (letter No. 176M., dated 30th April 1884) that such observations as the Government might have to make on the financial aspects of the question would follow. Up to date no further communication has been received in regard to this part of the subject. As the question, however, is one of extreme urgency, and the Committee have reason to believe that the Government of India are waiting for an expression of the Commissioners' opinion on the points raised, the Committee are of opinion that the Commissioners should now report to Government that they entirely concur in the opinion expressed by His Lordship the Secretary of State, that the construction of the docks should not be permitted to bring any ultimate charge on the general revenues of the country ; and they assume that His Lordship's objects would be attained provided the revenue yielded by the docks were sufficient to pay interest on the capital outlay. The scheme as submitted by the Port Commissioners was designed entirely upon this basis. The Committee have care-


V.

fully considered the possibility of raising the money required for the scheme either without or with a Government guarantee, and have had the advantage of consulting the Bank of Bengal. The conclusions the Committee have arrived at are—

(1) That without a Government guarantee it would be impracticable to raise the money except at such a rate of interest as would preclude the possibility of the scheme being self-supporting.

(2) That with a Government guarantee the Committee believe the money could be raised in England at about 3½ per cent., while in India it is doubtful if the large sum required could be readily got at 4½ per cent. A Port Trust loan, even if guaranteed by Government, would be looked upon by the public in quite a different way from Government paper. The latter commands a ready convertibility at home, as well as in this market, which the former could hardly be expected to attain.

24. But even with an Imperial guarantee, the Committee are of opinion that it would be unadvisable for the Commissioners to attempt to raise loans while the works are under construction. It would not be advisable to raise at once one loan for the whole amount, as that would involve unnecessary charges for interest on money not actually required. The same disadvantages would apply in a less degree to borrowing in instalments, with the additional objection that the terms to be obtained for a number of small loans would be less favourable to the borrowers. For these reasons the Committee recommend that the Commissioners' original stipulation, that Government should advance the necessary funds while the work is under construction, be adhered to, and that on completion of the work one guaranteed loan should be raised by the Commissioners, sufficient to repay to Government the whole of the advances made. Such an arrangement would materially assist the Trust, and keep down the charge for interest during construction to the smallest possible amount: while it appears to the Committee that by advancing the money required from sums to be raised specially for expenditure on railways, of which the docks may be considered an essential part, no inconvenience to Government would be likely to arise.

25. The Committee think that it should also be pointed out to Government that the Commissioners have already incurred expenditure for the acquisition of the land which is now being taken up under Government orders, and within a few weeks a very large portion of the land will have to be paid for. No further delay should therefore be allowed to occur in coming to an ultimate decision on this point. The proposals now made are, in the opinion of the Committee, the best which can be suggested in the interests of Government and of the general trade of the country, and under no other conditions, so far as the Committee see, can the scheme be successfully and economically carried out.

HORACE A. COCKERELL.
WM. DUFF BRUCE.
ROBT. STEEL.
J. J. J. KESWICK.
ROBERT MILLER.

KIDDERPORE DOCKS.

ABSTRACT OF REVISED ESTIMATES FOR DOCKS AT KIDDERPORE.

[*These Estimates include all alterations and additions recommended by the Government of India.*]

		R	R
ESTIMATE No. 1.	Sixty-feet Lock	17,15,779	
„ „ 2.	Eighty-feet Entrance to Tidal Basin	7,99,338	
„ „ 3.	Tidal Basin and 60-Ton Shears	12,95,142	
„ „ 4.	Double Entrance from Basin to Dock No. 1	12,60,134	
„ „ 5.	Dock No. 1	70,58,512	
„ „ 6.	„ No. 2	86,52,130	
„ „ 7.	Boat Canal	10,81,446	
„ „ 8.	Graving Dock	7,92,454	
„ „ 9.	Constructing Boat Wharves and extending the Tramway to the proposed Docks at Kidderpore	6,77,000	
			2,33,31,935
Add for Contingencies on works	@ 10 per cent.	...	23,33,193
„ „ Tools and plant	„ 3 „	...	6,99,958
„ „ Establishment	„ 5 „	...	11,66,597
	TOTAL .	...	2,75,31,683
„ „ Interest during construction	„ 12 „	...	27,99,832
	GRAND TOTAL .	...	3,03,31,515

W. DUFF BRUCE, C.E.,
Vice-Chairman.

An Estimate of saving effected if the Docks are made 500 feet wide instead of 600 feet.

DETAILS OF WORK.	Number.	MEASUREMENT.			Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.				
		Ft. In.	Ft. In.	Ft. In.	Bighas.	R a. p.	R	R
Land—								
Dock No. 1	...	2,590 0	100 0	...	17·98	1,500 0 0	26,970	...
„ No. 2	...	1,370 0	100 0	...	9·51	600 0 0	5,706	..
	...	2,745 0	100 0	...	19·06	250 0 0	4,765	37,441
Excavation	...	2,590 0	100 0	36 0	9,324,000	20 0 0	1,86,480	...
		4,115 0	100 0	36 0	14,814,000	20 0 0	2,96,280	4,82,760
Dock Walls	4	100 0	...	...	...	425 4 0	1,70,100	1,70,100
								6,90,301
Add for Contingencies on works @ 10 per cent.							69,030	
„ Tools and plant „ 3 „							20,709	...
„ Establishment „ 5 „							34,515	
								1,24,254
Interest during construction , 12 „							...	82 836
							TOTAL . .	8,97,391

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE, C.E.,
Vice-Chairman.

ESTIMATE No. 1.

An Estimate of the Cost of Constructing the 60-feet Lock, with Gates, Sluices, Jetty-heads, &c., complete.

DESCRIPTION OF WORK.	Number.	MEASUREMENT.			Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.			R a. p.	R	R
Excavation	...	372 0	184 0	24 0	1,642,752				
		244 0	184 0	24 0	1,077,504				
		130 0	149 0	24 0	464,880				
		290 0	108 0	17 0	532,440				
		160 0	108 0	17 0	293,760				
		210 0	73 0	17 0	260,610				
						4,271,946	20 0 0	85,439	
									85,439
Well-sinking	2	274 0	14 0	28 0	214,816				
	2	229 0	14 0	28 0	179,536				
	2	95 0	14 0	28 0	74,480				
	2	72 0	14 0	28 0	56,448				
	1	262 0	108 0	11 0	311,256				
	1	229 0	73 0	11 0	183,887				
	1	83 0	108 0	11 0	98,604				
	1	72 0	83 0	11 0	65,736				
						1,184,763	27 12 0	32,877	
									32,877
Cement brickwork in wells	2	274 0	14 0	2 0	15,344				
	2	229 0	14 0	2 0	12,824				
	2	95 0	14 0	2 0	5,320				
	2	72 0	14 0	2 0	4,032				
	1	262 0	108 0	2 0	56,592				
	1	229 0	73 0	2 0	33,434				
	1	83 0	108 0	2 0	17,928				
	1	72 0	83 0	2 0	11,952				
						157,426	50 0 0	78,713	
									78,713
Brickwork in hydraulic lime mortar in wells	2	274 0	14 0	26 0	199,472				
	2	229 0	14 0	26 0	166,712				
	2	95 0	14 0	26 0	69,160				
	2	72 0	14 0	26 0	52,416				
	1	262 0	108 0	8 3	233,442				
	1	229 0	73 0	8 3	137,915				
	1	83 0	108 0	8 3	73,953				
	1	72 0	83 0	8 3	49.302				
Add cills	3	53 4	27 0	1 0	4,320				
						986,692			
Deduct recesses	3	75 0	23 0	1 0	5,175				
	6	38 0	7 0	1 0	1,596				
						6,771			
						979,921	36 0 0	3,52,771	
									3,52,771
Brickwork in hydraulic lime mortar in walls— To datum line	6	92 0	26 7½	17 9	260,872				
	2	57 0	9 1½	17 9	18,464				
	2	207 0	9 1½	17 9	67,055				
	2	25 0	9 1½	17 9	8,099				
	2	60 0	9 1½	17 9	19,436				
						373,926			
Brickwork in hydraulic lime mortar in walls— To coping level	2	60 0	15 0	24 0	43,200				
	2	25 0	22 3	6 0	6,675				
	2	25 0	16 9	6 0	5,025				
	2	25 0	11 0	12 0	6,600				
	2	207 0	22 3	6 0	55 269				
	2	212 0	16 9	6 0	42,612				
	2	217 0	11 0	12 0	57,288				
	2	57 0	22 3	6 0	15,219				
	2	62 0	16 9	6 0	12,462				
	2	67 0	11 0	12 0	17,688				
	6	92 0	38 9	6 0	128.340				
	6	87 0	35 9	6 0	111,969				
	6	82 0	32 6	12 0	191,880				
						694,227			
Carried over	...	...	...	...	...	1,068,153	...	...	5,49,800

An Estimate of the Cost of Constructing the 60-feet Lock, with Gates, Sluices, Jetty-heads, &c., complete—continued.

DESCRIPTION OF WORK.	Number.	MEASUREMENT. L.	B.	D.	Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		Ft. In.	Ft. In.	Ft. In.			*R a. p.*	*R*	*R*
Brought forward	...	...	...	...	...	1,068,153	...	....	5,49,800
Deduct recesses	6	37 0	6 0	41 0	54,612				
Cement facing	2	625 0	1 0	41 0	51,250				
Do. do.	6	38 0	1 0	1 0	228				
						106,090			
						962,063	36 0 0	3,46,343	3,46,343
Cement brickwork facing to walls and floors	2	630 0	1 0	41 0	51,660				
	6	38 0	1 0	1 0	228				
		620 0	54 0	0 9	25,110				
	6	37 0	12 0	0 9	1,998				
		60 0	15 0	0 9	675				
						79,671			
DEDUCT	3	64 0	4 0	0 9	576				
	6	35 0	4 6	0 9	708				
						1,284			
						78,387	50 0 0	39,194	39,194
Granite quoins	84	7 0	5 6	3 0	9,702				
,, in sluices	36	7 0	2 0	3 0	1,512				
	18	7 0	3 0	2 6	945				
,, heel blocks	6	8 0	8 0	3 6	1,344				
						13,503	8 0 0	1,08,024	1,08,024
Mirzapore stone coping	...	1,340 0	3 0	1 6	6,030				
,, ,, quoins	84	5 0	3 6	3 0	4,410				
,, ,, cills	3	68 0	4 6	3 0	2,754				
,, ,, roller paths	6	35 0	4 6	2 0	1,890				
,, ,, to sluices	24	5 6	2 9	1 6	544½				
	6	5 6	2 9	2 0	181½				
	12	22 0	1 6	1 3	495				
	12	6 0	1 6	1 3	135				
	12	6 0	3 0	1 3	270				
To hydraulic machinery	6	5 0	5 0	2 0	300				
	24	5 6	3 6	2 0	924				
	6	4 0	4 0	2 0	192				
	6	10 0	4 0	1 0	240				
	12	65 0	1 6	0 6	585				
	12	5 0	1 6	0 6	45				
	12	3 0	1 6	0 6	27				
						19,023	4 0 0	76,092	76,092
Metalling	...	1,150 0	10 0	...	11,500	11,500	20 0 0	2,300	2,300
Jetty-head . . . Bays No.	72	(*Vide* details on page)			...	...	2,858 0 0	2,05,776	2,05,776
Coffer dam across entrance	...	150 0	...	...	...	...	200 0 0	30,000	30,000

60-feet gates, per pair, complete with machinery . . . . at £7,250

		R
£7,250 at par	=	72,500
Add for freight, exchange, &c., 33 per cent.		24,166
		96,666
Add for erection		8,334
Total per pair		1,05,000

Three pairs of gates . . . . at R1,05,000 per pair 3,15,00

Sluice machines for ditto complete . . . . at £200 each.

		R
£200 at par	=	2,000
Add for freight, exchange, &c., 33 per cent.		666
		2,666
Add for erection		834
TOTAL		3,500 each.

Carried over 16,72,5

An Estimate of the Cost of Constructing the 60-feet Lock, with Gates, Sluices, Jetty-heads, &c., complete—concluded.

			R
Brought forward			16,72,529
Six sluice machines for 60-feet gates	at R 3,500 each		21,000
Eleven-ton capstans	at £315 each.		
		R	
£315 at par		= 3,150	
Add for exchange, freight, &c., 33 per cent.		1,050	
		4,200	
Add for erection		300	
TOTAL		4,500 each.	
One 11-ton capstan	at R 4,500		4,500
Five-ton capstan	at £245 each.		
		R	
£245 at par		= 2,450	
Add freight, exchange, &c., 33 per cent.		816	
		3,266	
Add for erection		284	
TOTAL		3,550 each.	
Five 5-ton capstans	R 3,550 each		17,750
GRAND TOTAL			17,15,779

An Estimate of the cost per Bay, of 20 feet × 10 feet, of Entrance Jetties.

DESCRIPTION OF WORK.	Number.	MEASUREMENT.			Quantity.	Rate.	Amount.
		L.	B.	D.			
Timber Work.		Ft. In.	Ft. In.	Ft. In.	Cubic feet.	*R a. p.*	*R a. p.*
Main piles	2	62 0	1 2	1 2	168·77		
Ditto	2	63 0	1 2	1 2	171·50		
Walings	6	10 0	1 2	1 2	81·66		
Cross beams	1	22 0	1 2	1 2	29·94		
Horizontal bracing	1	27 0	1 1	0 6½	15·82		
Ditto	1	25 0	1 1	0 6½	14·66		
Diagonal bracing	...	110 0	1 1	0 6½	64·54		
Horizontal fenders	3	10 0	1 0	0 6	15·00		
Vertical ditto	1	23 0	1 0	0 6	11·50		
Cills	2	10 0	1 0	0 6	10·00		
Planking	...	10 0	18 6	0 3	46·25		
Railing	...	5 0	0 8	0 4	1·10		
Do.	...	10 0	0 6	0 4	1·66		
Do.	2	10 0	0 4	0 4	2·21		
			Total cubic feet		634·61		
			Say, 635 cubic feet			4 8 0	2,857 8 0
							Say R 2,858 per bay.

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE, C.E.,
Vice-Chairman.

ESTIMATE No. 2.

An Estimate of the Cost of Constructing the 80-feet Entrance, with Gates, Sluices, Jetty-heads, &c., complete.

DESCRIPTION OF WORK.	Number.	MEASUREMENT.			Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.			R a. p.	R	R
Excavation	...	298 0	204 0	24 0	1,459,008				
		212 0	128 0	17 0	461,312				
						1,920,320	20 0 0	38,406	
									38,406
Well-sinking	2	182 0	14 0	28 0	142,688				
		91 0	128 0	11 0	128.128				
		91 0	92 0	11 0	92,092				
						362,908	27 12 0	10,071	
									10,071
Brickwork in cement in wells .	2	182 0	14 0	2 0	10,192				
		91 0	128 0	2 0	23,296				
		91 0	92 0	2 0	16,744				
						50,232	50 0 0	25,116	
									25,116
Brickwork in hydraulic lime mortar in wells.	2	182 0	14 0	26 0	132,496				
		91 0	128 0	8 3	96,096				
		91 0	92 0	8 3	69,069				
Add cills		73 4	30 0	1 0	2,200				
						299,861			
Deduct recesses	1	98 0	28 0	1 0	2,744				
	2	47 0	9 0	1 0	846				
						3,590			
						296,271	36 0 0	1,06,657	
Brickwork in hydraulic lime mortar in walls.	2	130 0	26 7½	17 9	122,874				
	2	50 0	9 0	17 9	15,975				
	2	130 0	38 9	6 0	60,450				
	2	50 0	23 0	6 0	13,800				
	2	130 0	35 9	6 0	55.770				
	2	130 0	17 0	6 0	26.520				
	2	130 0	32 6	12 0	101,400				
	2	50 0	11 0	12 0	13,200				
						409,989			
Deduct recesses	2	47 0	6 0	41 0	23,124				
Cement facing	2	182 0	1 0	41 0	14,924				
	2	47 0	1 0	1 0	94				
						38,142			
						371,847	36 0 0	1,33,865	
									2,40,522
Cement facing to walls and floors .	2	182 0	1 0	41 0	14,924				
	2	47 0	1 0	1 0	94				
		182 0	74 0	0 9	10,101				
	2	47 0	15 0	0 9	1,057				
		45 0	10 0	0 9	337				
						26,513			
Deduct cill	1	90 0	4 0	0 9	270				
,, roller paths . . .	2	47 0	4 6	0 9	317				
						587			
						25,926	50 0 0	12,963	
									12,963
Granite quoins	28	7 0	5 6	3 0	3,234				
,, in sluices	12	8 0	2 0	3 0	576				
	6	8 0	3 0	2 6	360				
,, heel blocks . . .	2	8 0	8 0	3 6	448				
						4,618	8 0 0	36,944	
									36,944
Carried over . .		...	...	...	...	...	...	...	3,64,022

An Estimate of the Cost of Constructing the 80-feet Entrance, with Gates, Sluices, Jetty-heads, &c.—concluded.

Description of Work.	Number.	Measurement. L.	B.	D.	Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		Ft. In.	Ft. In.	Ft. In.	Cubic feet.		a. p.	R	R
Brought forward	...	...	...	...	...	......	...	...	3,64,022
Mirzapore stonework, coping	...	400 0	3 0	1 6	1,800				
„ „ quoins	28	5 0	3 6	3 0	1,470				
„ „ cill	1	90 0	4 6	3 0	1,215				
„ „ roller paths	2	47 0	4 6	2 0	846				
„ „ in sluice machines.	8	7 6	2 9	1 6	247½				
	2	7 6	2 9	2 0	82½				
	4	22 0	1 6	1 3	165				
	4	8 0	1 6	1 3	60				
	4	8 0	3 0	1 3	120				
„ „ for hydraulic machinery.	2	5 0	5 0	2 0	100				
	8	5 6	3 6	2 0	308				
	2	4 0	4 0	2 0	64				
	2	10 0	4 0	1 0	80				
	4	65 0	1 6	0 6	195				
	4	5 0	1 6	0 6	15				
	4	3 0	1 6	0 6	9	6,777	4 0 0	27,108	27,108
Metalling	...	300 0	10 0	...	3,000	3,000	20 0 0	600	600
Jetty-head . . . Bays No.	76	(*Vide* details on page 17, Estimate No. 1)				...	2,858 0 0	2,17,208	2,17,208
Coffer dam at entrance	..	150 0	...	...	...	...	200 0 0	30,000	30,000
80-feet gates, complete with machinery, &c.							at £9,750		
£9,750 at par =						R 97,500			
Add exchange, freight, &c., 33 per cent.						32,500			
						1,30,000			
Add for erection						10,000			
					Total per pair	1,40,000	at	R1,40,000	1,40,000
Sluice machines for 80-feet gates at							£250 each complete.		
£250 at par =						R 2,500			
Add freight, exchange, &c., 33 per cent.						833			
						3,333			
Add for erection						1,067			
					Total	4,400 per machine.			
Two sluice machines								at R 4,400	8,800
One 11-ton capstan, as per Estimate No. 1, page 17								at 4,500	4,500
Two 5-ton ditto ditto ditto								at 3,550	7,100
							Grand Total		7,99,338

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE, C.E.,
Vice-Chairman.

ESTIMATE NO. 3.

An Estimate of the Cost of Constructing the Tidal Basin.

DESCRIPTION OF WORK.	Number.	MEASUREMENT.			Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.			R a. p.	R	R
Quay wall, 50 feet high	...	2,030 0	...	...	...	...	441 4 0	8,95,738	8,95,738
Excavation	...	656 0	541 0	27 0	9,582,192				
	...	715 0	600 0	15 0	6,435,000	16,017,192	20 0 0	3,20,344	3,20,344
Metalling	...	2,030 0	10 0	...	20,300	20,300	20 0 0	4,060	4,060
									12,20,142
60-ton Shears									70,000
Bollards									5,000
							GRAND TOTAL		12,95,42

W. DUFF BRUCE, C.E.,
Vice-Chairman.

An Estimate of the Cost per Lineal Foot of Wells round the Tidal Basin.

DESCRIPTION OF WORK.	Number.	MEASUREMENT.			Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.			R a. p.	R	R
Excavation	...	12 6	84 0	27 0	28,350	28.350	20 0 0	567·00	
Well-sinking	2	12 6	12 6	23 0	7,187·5	7,187·5	27 12 0	199·46	
Cement concrete in kerbs and bottoming.	2	12 6	12 6	2 0	625	625	50 0 0	312·50	
Concrete in lime mortar, wells	2	6 8	6 8	21 0	1,866·66				
Ditto ditto, wall	5	9 2	9 0	3 0	1,237·50				
	1	9 2	2 9	2 0	50·50	3.154·66	30 0 0	946·39	
Stone-work, coping	...	12 6	3 6	1 6	65·625	65·625	4 0 0	262·50	
Brickwork in lime mortar, wells	2	12 6	12 6	21 0	6,562·50				
		12 6	17 10½	20 9	4,636·32				
		12 6	10 7½	6 3	830·08	12,028·90			
Deduct sub-way	...	12 6	2 9	3 7½	124·60				
Ditto	½	12 6	5·93	...	37·07				
Concrete hearting as above	...	...	...	...	3,154·66				
Stone-work as above	...	...	...	...	65·62	3,381·95			
						8,646·95	36 0 0	3,112·90	
Pointing in cement	...	12 6	45 9	...	571·87				
		12 6	14 4	...	179·16	751·03	6 0 0	45·06	
Sheet-piling	2	24 0	1 0	0 4	16·00	16·00	4 0 0	64·00	
Gratings	...	...	...	...	...	...	...	6·19	5,516·00

R 5,516 ÷ 12·5 Ft. = 441·28 rupees per foot, lineal.

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE, C.E.,
Vice-Chairman.

ESTIMATE No. 4.

An Estimate of the Cost of Constructing a Double Entrance with 60-feet and 80-feet Openings and Gates, complete with Swing Bridge, Sluices, Hydraulic Machinery, &c.

Description of Work.	Number.	Measurement.						Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.		B.		D.						
		Ft.	In.	Ft.	In.	Ft.	In.			*R a. p.*	R	R
Excavation	...	334	0	313	0	22	0	2,299,924				
		268	0	237	0	12	0	762,192				
									3,062,116	20 0 0	61,242	
												61,242
Well-sinking	2	94	0	14	0	24	0	63,168				
	2	84	0	14	0	24	0	56,448				
	2	92	0	14	0	24	0	61,824				
	1	92	0	205	0	12	0	226,320				
	1	84	0	205	0	12	0	206,640				
	1	66	0	237	0	12	0	187,704				
	1	233	0	14	0	2	0	6,524				
									808,628	27 12 0	22,439	
												22,439
Brickwork in cement in wells	2	94	0	14	0	2	0	5,264				
	2	84	0	14	0	2	0	4,704				
	2	92	0	14	0	2	0	5,152				
	1	92	0	205	0	2	0	37,720				
	1	84	0	205	0	2	0	34,440				
	1	66	0	237	0	2	0	31,284				
	1	233	0	14	0	2	0	6,524				
									125,088	50 0 0	62,544	
												62,544
Brickwork in hydraulic lime mortar in wells	2	270	0	14	0	22	0	166,320				
	1	170	0	205	0	8	3	297,660				
	1	66	0	237	0	8	3	129,046				
Add cills	1	53	4	27	0	1	0	1,440				
	1	73	4	30	0	1	0	2,200				
Brickwork in walls	2	92	0	9	1½	13	0	21,827				
	2	84	0	9	1½	13	0	19,929				
	2	66	0	26	7½	13	0	45,689				
Centre pier	1	240	0	53	0	38	6	489,720				
Side walls	2	82	0	32	6	12	0	63,960				
	2	87	0	35	9	6	0	37,323				
	2	92	0	38	9	7	6	53,475				
	2	158	0	11	0	12	0	41,712				
	2	153	0	16	9	6	0	30,753				
	2	148	0	22	3	7	6	49,395				
	2	35	0	7	0	12	0	5,880				
									1,456,329			
Deduct recesses	1	18	0	8	0	6	0	864				
	1	28	0	19	0	6	0	3,192				
	1	38	0	30	0	12	0	13,680				
	1	7	0	8	0	6	0	336				
	1	17	0	19	0	6	0	1,938				
	1	27	0	30	0	12	0	9,720				
	1	75	0	23	0	1	0	1,725				
	2	37	0	7	0	1	0	518				
	2	37	0	6	0	31	0	13,764				
	2	47	0	6	0	31	0	17,484				
	1	98	0	28	0	1	0	2,744				
	2	47	0	9	0	1	0	846				
Facing to walls	4	240	0	1	0	36	0	34,560				
									101,371			
									1,354,958	36 0 0	4,87,785	
												4,87,785
Cement brickwork in facing walls	4	242	0	1	0	37	0	35,816				
	2	37	0	1	0	1	0	74				
	2	47	0	1	0	1	0	94				
Floors	1	242	0	54	0	0	9	9,801				
	1	242	0	74	0	0	9	13,431				
	2	37	0	12	0	0	9	666				
	2	47	0	15	0	0	9	1,058				
	4	20	0	15	0	0	9	900				
									61,840	50 0 0	30,920	
												30,920
Granite quoins	48	7	0	5	6	3	3	6,006				
„ in sluice machines	12	7	0	2	0	3	0	504				
	6	7	0	3	0	2	6	315				
	12	8	0	2	0	3	0	576				
	6	8	0	3	0	2	6	360				
„ heel blocks	4	8	0	8	0	3	6	896				
									8,657	8 0 0	69,256	
												69,256
Carried over	...	...		...		...		...	...	...	...	7,34,186

An Estimate of the Cost of Constructing a Double Entrance, with 60-feet and 80-feet Openings and Gates complete with Swing Bridge, Sluices, Hydraulic Machinery, &c.—concluded.

Description of Work.	Number.	Measurement.			Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.			R a. p.	R	R
Brought forward	...	...	...	...	...	...	...	...	7,34,186
Mirzapore stone quoins	48	5 0	3 6	3 3	2,730				
,, ,, in roller paths	2	35 0	4 6	2 6	787½				
	2	47 0	4 6	2 6	1,057½				
,, in cills	1	68 0	4 6	3 0	918				
	1	90 0	4 6	3 0	1,215				
,, in coping	4	240 0	3 0	1 6	4,320				
	2	50 0	3 0	1 6	450				
,, in sluices	8	5 6	2 9	1 6	181½				
	2	5 6	2 9	2 0	60½				
	4	22 0	1 6	1 3	165				
	4	6 0	1 6	1 3	45				
	4	6 0	3 0	1 3	90				
	8	7 6	2 9	1 6	247½				
	2	7 6	2 9	2 0	82½				
	4	22 0	1 6	1 3	165				
	4	8 0	1 6	1 3	60				
	4	8 0	3 0	1 3	120				
	4	5 0	5 0	2 0	200				
	16	5 6	3 6	2 0	616				
	4	4 0	4 0	2 0	128				
	4	10 0	4 0	1 0	160				
	8	65 0	1 6	0 6	390				
	8	5 0	1 6	0 6	30				
	8	3 0	1 6	0 6	18				
Timber for Swing Bridge.						14,237	4 0 0	56,948	56,948
Planking	...	210 0	21 0	0 4½	1,653¾				
	2	210 0	6 0	0 3½	735				
Fenders	2	206 0	1 1	0 9	334¾				
Beams	2	210 0	0 8	0 4	93⅓				
	13	21 0	0 6	0 8	91				
Sleepers	2	210 0	1 6	0 9	472½	3,380⅓	4 0 0	13 521	
Cost of swing bridge over double entrance						£9,750			
£9,750 at par					R =97,500				
Add for freight, exchange, &c., 33 per cent.					32,500				
					1,30,000			1,30,000	
Add for erection								6,479	1,50,000
								R	
80-feet gates, one pair complete					*Vide* estimate No. 2, page 19, at 1,40,000 each				1,40,000
60-feet ditto, ditto					,, ,, No. 1, ,, 16 ,, 1,05,000 ,,				1,05,000
Two sluice machines for 60-feet gates					,, ,, No. 1, ,, 16 ,, 3,500 ,,				7,000
Two ditto ditto 80-feet do.					,, ,, No. 2, ,, 19 ,, 4,400 ,,				8,800
Two 11-ton capstans					,, ,, No. 1, ,, 17 ,, 4,500 ,,				9,000
Four 5-ton ditto					,, ,, No. 1, ,, 17 ,, 3,550 ,,				14,200
Timber dolphin									35,000
								Grand Total	12,60,134

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE, C.E.,
Vice-Chairman.

ESTIMATE No. 5.

An Estimate of the Cost of Constructing Dock No. 1.

Description of Work.	Number.	Measurement.			Quantity.	Total of quantities.	Rate.	Amount.	Total of amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.		Bighas.	R a. p.	R	R
Land	...	...	...	...	...	323	1,500 0 0	4,84,500	4,84,500
Dock wall	...	6,435 0	...	...	...	...	425 4 0	27,36,484	27,36,484
Excavation	...	2,535 0	445 0	25 0	34,539,375				
	...	2,590 0	600 0	11 0	17,094,000	51,633,375	20 0 0	10,32,668	10,32,668
Cargo sheds	12	300 0	120 0	...	432,000	432,000	3 0 0	12,96,000	12,96,000
Dock offices	...	...	...	...	...	...	...	40,000	
Quarters for Dock Master, Engineers, &c.	...	...	...	...	...	...	...	2,00,000	
Out-offices for ditto ditto	...	...	...	...	...	...	...	12,000	2,52,000
Engine-house	1	60 0	60 0	...	3,600	3,600	4 8 0	16,200	
	1	56 0	45 0	...	2,520	2,520	3 8 0	8,820	
Chimney	...	...	...	...	...	...	...	5,000	
Accumulator towers	2	...	...	...	...	...	5,000 0 0	10,000	40,020
Hydraulic crane engines	...	...	...	...	...	...	...	2,00,000	2,00,000
Shed for coals, store, and workshop	...	200 0	40 0	...	8,000	8,000	3 0 0	24,000	24,000
35-cwt. hydraulic cranes	30	...	...	...	...	...	7,500 0 0	2,25,000	2,25,000
Pressure pipes	...	...	...	...	...	...	...	75,000	75,000
One-ton capstans	10	...	...	...	...	...	1,850 0 0	18,500	18,500
					Miles.	Miles.			
Tramway, 5′ 6″ gauge	...	...	...	...	6½	6½	35,000 0 0	2,27,500	2,27,500
Traversers	6	...	...	...	...	...	3,000 0 0	18,000	18,000
Crane lines	...	...	...	...	Ft. 5,200	Ft. 5,200	5 0 0	26,000	26,000
Metalling, compounding, and gully pits.	...	...	...	...	1,179,200	1,179,200	20 0 0	2,35,840	2,35,840
Fencing round the Dock premises	...	...	...	...	13,200	13,200	10 0 0	1,32,000	1,32,000
Electric lighting	...	...	...	...	...	...	...	25,000	25,000
Bollards	...	...	...	...	...	...	...	...	10,000
GRAND TOTAL	...	...	...	...	...	...	...	...	70,58,512

P. SOUTTER,
Assistant Engineer.

W. DUFF BRUCE, C.E.,
Vice-Chairman.

Details of Cost of Machinery.

Two pairs of compound condensing steam pumping engines, each 230 actual horse-power, with boilers, tank, accumulator (20 inches diameter × 35 feet stroke), and pipes and accessories within the engine, boiler, and accumulator houses, complete, £13,000.

	R
£13,000 at par	= 1,30,000
Add for freight, exchange, &c., 33 per cent.	43,333
	1,73,333
Add for erection, foundations, &c.	26,667
Total	2,00,000

One-ton hydraulic capstans £120 each.

£120 at par	= 1,200
Add for freight, exchange, &c., 33 per cent.	400
	1,600
Add for erection	250
Total	1,850 per capstan.

35-cwt. hydraulic cranes at £530 each.

£530 at par	= 5,300
Add for freight, exchange, &c., 33 per cent.	1,766
	7,066
Add for erection	434
Total	7,500 per crane.

An Estimate of the Cost, per lineal foot, of Dock Walls.

Description of Work.	Number.	Measurement.			Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.			R a. p.	R	R
Excavation	...	12 6	80 0	25 0	25,000	25,000	20 0 0	500·00	
Well-sinking	2	12 6	12 6	19 0	5,937·5	5,937·5	27 12 0	164·76	
Cement concrete in kerbs and bottoming.	2	12 6	12 6	2 0	625	625	50 0 0	312·50	
Concrete in line mortar, wells	2	6 8	6 8	17 0	1,511·11				
Ditto ditto, wall	...	9 2	52 6	3 0	1,443·75				
	...	9 2	6 0	2 0	110·00	3,064·86	30 0 0	919·45	
Stonework, front coping	...	12 6	3 6	1 6	65·625				
Ditto, back do.	...	12 6	1 0	1 6	18·750	84·375	4 0 0	337·50	
Brickwork in hydraulic line mortar, wells.	2	12 6	12 6	17 0	5,312·50				
Ditto ditto, wall	...	12 6	19 7½	20 9	5,090·22				
	...	12 6	14 3	7 9	1,380·47	11,783·19			
Deduct sub-way	...	12 6	6 0	3 0	225·00				
	...	12 6	× 14·13	...	176·62				
Concrete hearting as above	...	...	...	...	3,064·86				
Stonework ditto	..	...	...	...	84·37	3,550·85			
						8,232·34	36 0 0	2963·64	
Cement pointing	...	12 6	43 0	...	537·50				
	...	12 6	21 6	...	268·75	806·25	6 0 0	48·37	
Sheet piling	2	20 0	1 0	0 4	13·33	13·33	4 0 0	53·32	
Gratings	...	...	...	...	...	...	...	15·46	5315·00

R5,315÷12·5 feet = 425·20 rupees per foot, lineal.

P. SOUTTER,	W. DUFF BRUCE, C.E.,
Assistant Engineer.	*Vice-Chairman.*

ESTIMATE No. 6.

An Estimate of the Cost of Constructing Dock No. 2.

DESCRIPTION OF WORK.	Number.	MEASUREMENT.			Quantity.	Total of quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.		Bighas.	R a. p.	R	R
Land	...	...	...	...	...	323	600 0 0	1,93,800	
	...	...	...	...	...	647	250 0 0	1,61,750	3,55,550
Dock wall	...	9,400·0	(*Vide* details, estimate No. 5, page)				425 4 0	39,97,350	39,97,350
Excavation	...	4,060·0	545·0	25·0	55,317,500			16,49,530	16,49,530
		4,115·0	600·0	11·0	27,159,000	82,476,500	20 0 0		
Cargo sheds	10	150 0	120 0	...	180,000	180,000	3 0 0	5,40,000	5,40,000
Salt golahs	6	140·0	120·0	...	100,800	100,800	3 8 0	3,52,800	3,52,800
Pumping engines for Docks	...	...	...	...	...	...	...	2,00,000	
Engine and boiler houses	...	...	...	...	...	...	...	25,000	
Chimney	...	...	...	...	...	...	...	5,000	2,30,000
Culvert for water-supply	...	...	...	...	...	...	...	15,000	15,000
Drawbridge between Docks Nos. 1 and 2.	...	...	...	...	...	...	...	1,60,000	1,60,000
Drawbridge over boat entrance	...	...	...	...	...	...	...	30,000	30,000
Accumulator tower	1	...	...	...	...	...	...	...	5,000
35-cwt. hydraulic cranes	20	...	(*Vide* estimate No. 5, page)			...	7,500 0 0	...	1,50,000
Pressure pipes	...	...	...	...	...	...	...	...	75,000
One-ton capstans	10	...	(*Vide* estimate No. 5, page)			...	1,850 0 0	...	18,500
Tramway, five feet six inches gauge, round Dock, and from Dock to Canal.	...	...	...	...	Miles. 17	Miles. 17	35,000 0 0	5,95,000	5,95,000
Traversers	9	...	...	...	...	...	3,000 0 0	27,000	27,000
Crane lines	...	8,450·0	...	...	...	8,450	5 0 0	42,250	42,250
Metalling and gully-pits	...	...	...	...	...	1,175,750	20 0 0	2,35,150	2,35,150
Fencing round Dock premises	...	13,900·0	...	...	...	13,900	10 0 0	1,39,000	1,39,000
Electric lighting	...	...	...	...	...	...	...	25,000	25,000
Bollards	...	...	...	...	...	...	...	10,000	10,000
							GRAND TOTAL		86,52,130

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ESTIMATE No. 7.

An Estimate of the Cost of Constructing the Boat Canal from the Docks to Tolly's Nullah.

DETAILS OF WORK.	Number.	MEASUREMENT.			Quantity.	Total of quantities.	Rate.	Amount.	Total of Amounts.
		L.	B.	D.					
		Ft. In.	Ft. In.	Ft. In.		Bighas.	R a. p.	R	R
Land	...	...	...	...	...	525	250 0 0	1,31,250	1,31,250
Excavation	...	10,390 0	120 0	20 0	24,936,000				
		4,810 0	144 0	12 0	8,311,680				
		4,810 0	180 0	2 0	1,731,600				
		350 0	143 0	34 0	1,701,700	36,680,980	10 0 0	3,66,810	3,66,810
Turfing	2	10,390 0	60 0	...	1,246,800				
	2	4,810 0	40 0	...	384,800				
	2	350 0	50 0	...	35,000				
	1	211 0	50 0	...	10,550	1,677,150	5 0 0	8,386	8,386
Road Bridges	3	...	...	...	...	...	50,000 0 0	1,50,000	1,50,000
Boat Lock	...	...	...	...	...	...	...	...	4,25,000
							GRAND TOTAL		10,81,446

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ESTIMATE NO. 8.

An Estimate of the Cost of Constructing a Graving Dock, 520 feet long on the blocks, with an Entrance 70 feet wide.

DESCRIPTION OF WORK.	Measurement.	Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
			Feet.	R a. p.	R	R
Excavation	1 @ 575′ 0″ × 152′ 0″ × 24′ 0″	2,097,600				
	1 ,, 545′ 0″ × 76′ 0″ × 5′ 6″	227,810				
	$\frac{24}{6}$ $(31416 + 8495 + \sqrt{31416 \times 8495})$	224,988				
			2,550,398	20 0 0	51,008	51,008
Cement brickwork in wells	2 @ 540′ 0″ × 14′ 0″ × 2′ 0″	30,240				
	½ (8494·8—4536·5) × 2′ 0″	3,958				
	1 @ 540′ 0″ × 76′ 0″ × 2′ 0″	82,080				
	½ (4536·5 × 2′ 0″)	4,537				
			120,815	50 0 0	60,408	60,408
Brickwork in hydraulic lime mortar in wells.	2 @ 540′ 0″ × 14′ 0″ × 13′ 6″	204,120				
	½ (8494·8—4536·5) × 13′ 6″	26,718				
	1 @ 540′ 0″ × 76′ 0″ × 8′ 0″	328,320				
	½ (4536·5 × 8′ 0″)	18,146				
	1. @ 82′ 0″ × 12′ 0″ × 5′ 6″	5,412				
			582,716	36 0 0	2,09,778	2,09,778
Well-sinking	2 @ 540′ 0″ × 14′ 0″ × 15′ 6″	234,360				
	½ (8494·8—4536·5) × 15′ 6″	30,677				
	1 @ 540′ 0″ × 76′ 0″ × 10′ 0″	410,400				
	½ (4536·5 × 10′ 0″)	22,682				
	1 @ 82′ 0″ × 12′ 0″ × 5′ 6″	5,412				
			703,531	27 12 0	19,523	19,523
Brickwork in hydraulic lime mortar in walls.	1 @ 475′ 0″ × 102′ 0″ × 24′ 0″	1,162,800				
	1 ,, 475′ 0″ × 76′ 0″ × 5′ 6″	198,550				
	½ (8171·3 × 24′ 0″)	98,056				
	½ (4536·5 × 5′ 6″)	12,475				
	2 @ 65′ 0″ × 12′ 6″ × 12′ 0″	19,500				
	2 ,, 65′ 0″ × 15′ 3″ × 6′ 0″	11,895				
	2 ,, 65′ 0″ × 17′ 9″ × 6′ 0″	13,845				
	1 ,, 65′ 0″ × 76′ 0″ × 5′ 6″	27,170				
Steps	7 ,, 16′ 0″ × 8′ 0″ × 3′ 6″	3,136				
			1,547,427			
Deduct	1 @ 475′ 0″ × 90′ 0″ × 2′·60	111,150				
	1 ,, 475′ 0″ × 87′ 6″ × 2′·60	108,062				
	1 ,, 475′ 0″ × 85′ 0″ × 2′·60	104,975				
	1 ,, 475′ 0″ × 82′ 6″ × 2′·60	101,888				
	1 ,, 475′ 0″ × 80′ 0″ × 2′·60	98,800				
	1 ,, 475′ 0″ × 77′ 6″ × 2′·60	95,712				
	1 ,, 475′ 0″ × 75′ 0″ × 2′·60	92,625				
	1 ,, 475′ 0″ × 72′ 6″ × 2′·60	89,538				
	1 ,, 475′ 0″ × 70′ 0″ × 2′·60	86,450				
	1 ,, 475′ 0″ × 67′ 6″ × 2′·60	83,363				
	1 ,, 475′ 0″ × 60′ 0″ × 3′·50	99,750				
	½ (6361·7 × 2′·60)	8,270				
	½ (6013·2 × 2′·60)	7,817				
	½ (:674·5 × 2′·60)	7,377				
	½ (5345·6 ÷ 2′·60)	6,949				
	½ (5026·5 × 2′·60)	6,534				
	½ (4717·3 × 2′·60)	6,133				
	½ (4417·9 × 2′·60)	5,743				
	½ (4128·2 × 2′·60)	5,367				
	½ (3848·5 × 2′·60)	5,003				
	½ (3578·5 × 2′·60)	4,652				
	½ (2827·4 × 3′·50)	4,948				
	1 @ 15′ 0″ × 60′ 0″ × 5′ 6″	4,950				
Cill	15′ 0″ × 65′ 8″ × 2′ 0″	1,970				
Apron	35′ 0″ × 70′ 0″ × 5′ 6″	13,475				
	2 @ 66′ 0″ × 3′ 6″ × 2′ 0″	924				
	1 ,, 74′ 0″ × 3′ 6″ × 3′ 0″	777				
Heel blocks	115 ,, 5′ 0″ × 3′ 0″ × 2′ 0″	3,450				
	1 ,, 100′ 0″ × 3′ 6″ × 2′ 0″	700				
Steps and inclines	½ ,, 35′ 0″ × 8′ 0″ × 8′ 0″	7,840				
Cement facing floor	1 @ 490′ 0″ × 60′ 0″ × 9″	22,050				
	½ (2827·4 × 9″)	1,060				
,, entrance walls	80′ 0″ × 1′ 0″ × 29′ 6″	2,360				
	70′ 0″ × 1′ 0″ × 26′ 0″	1,820				
,, altars	2 @ 490′ 0″ × 3′ 9″ × 1′ 0″	3,675				
	2 ,, 490′ 0″ × 2′ 6″ × 1′ 0″	2,450				
	½ (3578·5 — 2827·4) × 1′ 0″	376				
	½ (188·5 × 2′ 6″) × 1′ 0″	236				
	18 @ 490′ 0″ × 1′ 3″ × 1′ 0″	11,025				
	½ (6361·7 — 3578·5) × 1′ 0″	1,392				
	20 @ 490′ 0″ × 1′ 0″ × 1′·60	15,680				
	½ (282·7 × 1′ 0″) × 1′·60	226				
	½ (274·9 × 1′ 0″) × 1′·60	220				
	½ (267·0 × 1′ 0″) × 1′·60	214				
	½ (259·2 × 1′ 0″) × 1′·60	207				
	½ (251·3 × 1′ 0″) × 1′·60	201				
	½ (243·5 × 1′ 0″) × 1′·60	195				
	½ (235·6 × 1′ 0″) × 1′·60	188				
	½ (227·8 × 1′ 0″) × 1′·60	182				
	½ (219·9 × 1′ 0″) × 1′·60	176				
	½ (212·1 × 1′ 0″) × 1′·60	169				
Cill	8′ 0″ × 66′ 0″ × 0′ 9	396				
			1,239,690			
			307,737	36 0 0	1,10,785	1,10,785
	Carried over	...	...	...	...	4,51,502

As Estimate of the Cost of Constructing a Graving Dock, 250 feet long on the blocks, with an Entrance 70 feet wide—concluded.

Description of Work.	Measurement.	Quantity.	Total of Quantities.	Rate.	Amount.	Total of Amounts.
			Feet.	R a. p.	R	R
	Brought forward . . .	...	...	...	...	4,51,502
Concrete to steps and inclines .	7 @ 10' 0" × 10' 6" × 12' 0"	8,820				
	½ ,, 10' 0" × 10' 6" × 10' 0"	3,675				
			12,495	26 0 0	3,249	
Cement facing to floor, altars, &c.	as above.	64,498				3,249
			64,498	50 0 0	32,249	
Metalling	2 @ 630' 0" × 10' 0"	12,600				32,249
	½ ,, (11690—8171)	1,760				
	7 ,, 23' 0" × 10' 0'	1,610				
			15,970	20 0 0	3,194	
Stone-work, coping . .	2 @ 625' 0" × 3' 0" × 1' 6"	5,625				3,194
	½ ,, (7238·2—6361·7) × 1' 6"	657				
	14 ,, 13' 0" × 3' 0" × 1' 0"	546				
	7 ,, 10' 0" × 5' 0" × 1' 3"	350				
	140 ,, 3' 0" × 2' 0" × 1' 6"	1,260				
Heel blocks	115 ,, 5' 0" × 3' 0" × 2' 0"	3,450				
	65' 8" × 3' 6" × 2' 0"	460				
	74' 0" × 3' 6" × 3' 0"	777				
	100' 0" × 3' 6" × 2' 0"	700				
Quoins	24 @ 6' 0" × 2' 6" × 2' 6"	900				
	20 ,, 4' 0" × 2' 6" × 2' 6"	500				
			15,225	4 0 0	60,900	
Hand railing	No. 7, Bays.	...	...	40 0 0	280	60,900
Caisson	1 @ 74' 0" × 30' 0"	2,220				280
			2,220	34 0 0	75,480	
Capstans	1 11-ton capstan	*Vide* Estimate No. 1 for details.		4,500 0 0	4,500	75,480
	2 5-ton ,,			3,550 0 0	7,100	
Bollards	......	......		...	...	11,600
						4,000
				Total . .		6,42,454
Dock pumping engines, sluices, &c.						1,50,000
				Grand Total .		7,92,454

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Estimate No. 9.

An Approximate Estimate of the Cost of Constructing Boat Wharves from Chandpaul Ghât to Outram Road, and from Prinsep's Ghât to the Government Dockyard; and extending the Tramway from the Jetties to the proposed Docks at Kidderpore.

	Rate.	Amount.	Total Amount.
WHARF FROM CHANDPAUL GHAT TO OUTRAM ROAD.	R	R	R
298,000 Superficial feet of metalling on wharf and slopes	10	29,800	
351,000 ,, of dressing reclamation	5	1,755	
Add for cutting and filling	...	2,445	
			34,000
EMBANKMENT FROM OUTRAM ROAD TO THE BOAT HOUSE.			
1,000 Lineal feet of wharf with slope in front	40	44,000	
			44,000
EMBANKMENT FROM BOAT HOUSE TO THE SOUTH SIDE OF FORT POINT.			
1,100 Lineal feet of embankment on iron piles	150	1,50,000	
			1,50,000
EMBANKMENT FROM FORT POINT TO TOLLY'S NULLAH.			
11,000,000 Cubic feet earthwork in making up a wharf 100 feet wide . . .	10	1,10,000	
690,000 Superficial feet metalling on wharf and slope	10	69,000	
			1,79,000
EXTENSION OF TRAMWAYS FROM JETTIES TO PROPOSED DOCKS.			
Double line of tramway throughout, except at the Bridge. Sidings to be provided from Chandpaul Ghât to Outram Road, and from Prinsep's Ghât to the Bridge. Total length of single truck, 5½ miles	30,000	1,65,000	
A Lifting Bridge for carrying a single line of tramway across the entrance to the Canal, 110 feet, in clear between the abutments	...	1,05,000	
			2,70,000
GRAND TOTAL . .		...	6,77,000

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APPENDIX A.

NOTE ON EARTHWORK.

In paragraph 16 of the Committee's Report it is explained that the earthwork in the excavation of the docks will be taken out dry by coolie labour to a depth of 3 feet below datum, or to (on the average) 26 feet below the present surface of the ground. Below this level, and down to the bottom of the docks, which will be finished at a depth of 14 feet below datum, the excavation will be made by means of hydraulic dredgers. The dredged material will be discharged into barges fitted with moveable boxes, each box being large enough to hold 100 cubic feet, or about 5 tons, and each barge fitted with twelve of such boxes. The barges when loaded will be removed to the quay wall, where cranes will be erected to lift the boxes from the barges and discharge the contents into railway wagons.

2. The total quantity of earthwork to be executed in the construction of the docks is shown in the following statement:—

	Cubic Feet.	Total Cubic Feet.
Excavation in 60-feet Lock	5,456.709	
Ditto 80-feet Entrance	2,283,228	
Ditto Tidal Basin	16,640,482	
Ditto Dock No. 1 and Double Entrance	52,782,744	
Ditto Dock No. 2	76,113,500	
		153,276,663
In addition to the above, the following quantities will have to be dredged:—		
In Tidal Basin	5,148,000	
„ Dock No. 1	18,648,000	
„ Dock „ 2	29,628,000	
		53,424,000
Total cubic feet	...	206,700,663
To arrive at the quantity that will have to be removed to the spoil banks, the quantity required for making up behind, and backing the quay walls, must be deducted, *viz.*	...	307,00,000
Total quantity to be removed	...	176,000,663

3. In this quantity, the earthwork to be excavated from the boat canal has not been included, as the whole of the earth excavated from the canal will be deposited on its banks.

4. To ascertain the number of wagons and engines that will be required for the removal of this quantity of earthwork, it may be assumed that it will take three years to complete this excavation. The quantity to be removed per year of 300 days will be $\frac{176,000,000 \text{ cubic feet}}{3 \text{ years}} =$ 58,666,666 cubic feet, or, per day, $\frac{58,666,666 \text{ cubic feet}}{300 \text{ days}} = 195,555$ cubic feet; and taking the load of a truck at 200 cubic feet, it would require $\frac{195,555 \text{ cubic feet}}{200 \text{ cubic feet}} = 977$ truck loads to remove this quantity daily. Assuming it will take one hour to load and another to unload a truck, each truck will make in a working day of 10 hours, $\frac{10}{2} = 5$ trips; and as each truck will carry 200 cubic feet per trip, 200 cubic feet × 5 trips = 1,000 cubic feet removed per wagon per day. As the total quantity to be removed will be about 200,000 cubic feet, $\frac{200,000}{1,000} = 200$ wagons will be required for removal of soil. These wagons would be divided into eight trains of 25 wagons each, and this number of wagons when loaded would make a train of about 400 tons to be drawn by each locomotive. Four locomotives would be sufficient to work these eight trains, and the plant required for the removal of the earth would therefore be four locomotives and 200 wagons. Five miles of permanent-way and temporary sheds for the engines would also be required.

5. The following is an estimate of the cost of the plant, and charges for maintenance, and working expenses, for three years :—

	R	R
Cost of plant—		
Four locomotives, at R16,250	65,000	
Two hundred wagons, at R1,200	2,40,000	
Five miles permanent-way, at R25,000	1,25,000	
Temporary sheds	6,000	
Working expenses—		
For four locomotives for three years, including all charges for fuel, guards, and establishment, at R500 per mensem, or R6,000 per annum, each	72,000	
Maintenance of wagons and locomotives for three years, at R20,000 per annum	60,000	
Maintenance and shifting tramway lines for three years, at R12,000 per annum	36,000	6,04,000
Deduct probable value of plant on completion of work—		
Four locomotives, at R10,000 each	40,000	
Two hundred wagons, at R400 each	80,000	1,20,000
Total	...	4,84,000

As the total quantity of earth to be removed by this plant will be 176,000,000 cubic feet, the cost of removal per thousand cubic feet would be $\frac{\text{R}4{,}84{,}000 \times 1{,}000 \text{ cubic feet}}{176{,}000{,}000 \text{ cubic feet}} = \text{R}2{\cdot}75$, or say R3 per thousand cubic feet.

6. For the excavation of that portion of the work which would have to be executed by coolie labour, the following may be taken as the rates at which the earthwork could be excavated and carried to a mean distance of 300 feet and loaded into wagons :—

	Total number of men.	Cutters.	Carriers.	Rate.	Amount.	Rate per 1,000 cubic feet.
				R a. p.	R a. p.	R a. p.
Depth from 0 foot to 3 feet . .	19	4	...	0 7 0	1 12 0	
	...	...	15	0 4 0	1 12 0	5 8 0
Ditto 3 feet to 6 " . .	20	4	...	0 7 0	1 12 0	
	...	...	16	0 4 0	4 0 0	5 12 0
Ditto 6 " to 9 " . .	21	4	...	0 7 0	1 12 0	
	...	...	17	0 4 0	4 4 0	6 0 0
Ditto 9 " to 12 " . .	22	4	...	0 7 0	1 12 0	
	...	...	18	0 4 0	4 8 0	6 4 0
Ditto 12 " to 15 " . .	23	4	...	0 7 0	1 12 0	
	...	...	19	0 4 0	4 12 0	6 8 0
Ditto 15 " to 18 " . .	24	4	...	0 7 0	1 12 0	
	...	...	20	0 4 0	5 0 0	6 12
Ditto 18 " to 21 " . .	25	4	...	0 7 0	1 12 0	
	...	...	21	0 4 0	5 4 0	7 0 0
Ditto 21 " to 24 " . .	26	4	...	0 7 0	1 12 0	
	...	...	22	0 4 0	5 8 0	7 4 0
Ditto 24 " to 27 " . .	27	4	...	0 7 0	1 12 0	
	...	...	23	0 4 0	5 12 0	7 8 0

7. For the purposes of this calculation, it will be assumed that the maximum rate shown above, *viz.*, R7-8-0, will be paid for the excavation of the whole of the earthwork and the removal of the soil to a distance of 300 feet by coolie labour. In making up the embankments to which the earth will have to be removed, the railway lines will be so arranged that the earth will never have to be carried to a greater distance than 100 feet from the point at which it will be deposited by the trains. Five rupees per thousand cubic feet would therefore be an ample allowance for unloading the wagons and making up and dressing the embankments.

The total cost of earthwork to be done by coolie labour would therefore be—

	Per thousand cubic feet. R	a.	p.
Excavating and loading wagons	7	8	0
Removal to embankment by railway wagons	3	0	0
Unloading wagons and making up embankments	5	0	0
Total	15	8	0

8. It has been shown in paragraph 2 that the quantity of earth that will have to be dredged is about 53,424,000 cubic feet. This work it is proposed to do by hydraulic dredgers similar to those employed on the Midnapore Canals. From the actual experience gained in the working of these dredgers during the last four years, it has been shown by Mr. Vertannes, Superintending Engineer, Public Works Department, that these dredgers are capable of excavating, when working only eight hours per day, 4,000,000 cubic feet per annum, at a total cost of R8,000, including all charges for establishment and repairs. To do the work in about two years, it will be necessary to dredge $\frac{53{,}424{,}000 \text{ cubic feet}}{2 \text{ years}} = 26{,}712{,}000$ cubic feet annually, and allowing that each dredger will do 4,000,000 cubic feet per annum, it would require six dredgers to complete the work in 2¼ years. By working longer hours, or at night, the work could be completed in two years. Each dredger would require two barges to keep it regularly at work—one barge to be loading while the other was discharging; and at least three spare barges should be provided to replace those under repairs. For unloading the barges, six 10-ton cranes would be wanted; but the cranes used for working the excavators employed in sinking the wells will be used for this purpose, as the well-sinking will have been finished before the dredging is commenced.

9. The cost of dredging plant would be as follows:—

	R	R	R
6 Dredgers, each at	65,000	3,90,000	
15 Barges „	15,000	2,25,000	
Working expenses and repairs of 6 dredgers for 2¼ years, at per annum	8,000	1,08,000	
Working expenses of 15 barges, at R60 per month each, for 2¼ years	...	24,300	
Working expenses of 6 cranes, at R150 per month each, for 2¼ years	...	24,300	
Add for maintenance and repairs of barges and cranes, for 2¼ years	10,000	22,500	
			7,94,100

On the completion of the work these dredgers and barges would be required for dredging the canal, and an allowance of R30,000 for each dredger and R7,000 for each barge should be taken as the value of this plant.

Deduct 6 dredgers at	30,000	1,80,000	
Do. 15 barges at	7,000	1,05,000	
			2,85,000
Balance, being cost of dredging and loading dredged material into railway wagons			5,09,100

The total quantity of earth which this plant is estimated to remove is 53,424,000 cubic feet, at a cost of R5,09,100, giving a rate of R9·52, or say R9-8-0, per thousand cubic feet.

The total cost of excavating and removing to embankment the earth taken out by dredgers will therefore be—

	Per thousand cubic feet. R	a.	p.
Dredging and loading into wagons	9	8	0
Cost of removal by train	3	0	0
Unloading wagons and making up embankments	5	0	0
Total	17	8	0

as compared with R15-8-0 for excavating the earth by hand labour, and for which items of work R20 per thousand cubic feet has been provided in the estimates. It should also be noted that the same rate of R20 per thousand cubic feet has been provided for the 30,700,000 cubic feet required to make up the ground behind the quay walls, and for which R10 per thousand cubic feet would be ample.

10. The cost of pumping will be merely the cost of working the graving dock engines during the time the excavations are being taken out by hand, as it is proposed to erect these engines as soon as possible, and to utilise them while the work is in progress.

11. After carefully considering the whole question, I see no reason to doubt but that the rate of R20 per thousand cubic feet provided in the estimates will be ample for the work, and it is not at all improbable that a large saving may be effected.

12. The other principal items in the estimates are—

(1) Brickwork in cement.
(2) Ditto in hydraulic lime mortar.
(3) Concrete in cement.
(4) Ditto in the hydraulic lime.

The following statement shews the details of cost of each item, and from this it will be seen the rates taken in the estimates are ample for the class of work to be done :—

DESCRIPTION OF WORK.	Quantities.	DETAILS OF COST.	RATE.		Amount.	Total of Amounts.
			Amount.	Per		
			R a. p.		R a. p.	R a. p.
		Materials—				
Brickwork in cement . . .	1,200	1st class bricks . . .	13 8 0	1,000	16 3 2	
	12 c. ft.	Portland cement . .	1 12 0	c. ft.	21 0 0	
	24 „	Mugra sand . . .	15 0 0	100 c. ft.	3 9 6	
		Cost of materials .	...	...	...	40 12 8
		Labour	...	...	4 8 0	
		Tools, watering, &c. . .	...	...	1 11 4	6 3 4
		Total rate .	...	...	...	47 0 0
		Rate allowed in Estimates .	50 0 0	100 *c. ft.*		
		Materials—				
Brickwork in hydraulic lime mortar	1,200	1st class bricks . . .	13 8 0	1,000	16 3 2	
	18 c. ft.	Lime	30 0 0	100 c. ft.	5 6 4	
	18 „	Soorkey	15 0 0	100 „	2 11 3	
		Cost of materials . .	...	...	...	24 4 9
		Labour	...	...	4 8 0	
		Tools, watering, &c. . .	...	...	1 11 3	6 3 3
		Total rate .	...	...	...	30 8 0
		Rate allowed in Estimates .	36 0 0	100 *c. ft.*		
		Materials—				
Concrete in cement . . .	100 c. ft.	Jhama khoa . . .	11 0 0	100 c. ft.	11 0 0	
	15 „	Portland cement . .	1 12 0	c. ft.	26 4 0	
	30 „	Sand	15 0 0	100 c. ft.	4 8 0	
		Cost of materials .	...	...	...	41 12 0
		Labour	...	...	3 8 0	
		Petty charges, tools, &c. .	...	...	0 8 0	4 0 0
		Total rate .	...	...	...	45 12 0
		Rate allowed in Estimates .	50 0 0	100 *c. ft.*		
		Materials—				
Concrete in hydraulic line . .	100 c. ft.	Jhama khoa	11 0 0	100 c. ft.	11 0 0	
	22½ „	Lime	30 0 0	100 „	6 12 0	
	22½ „	Soorkey	15 0 0	100 „	3 6 0	
		Cost of materials .	...	...	...	21 2 0
		Labour	...	...	3 8 0	
		Petty charges . . .	...	...	0 8 0	4 0 0
		Total rate .	...	...	...	25 2 0
		Rate allowed in Estimates .	30 0 0	100 *c. ft.*		

W. DUFF BRUCE, C.E.,
Vice-Chairman.

From—Col. S. T. TREVOR, R. E., Secy. to the Govt. of Bengal, P. W. Dept., to Secretary to the Government of India, P. W. Dept.,—No. 1228 M P I, dated 17th July 1884.

With reference to the correspondence noted on the margin, I am now directed by His Honor the Lieutenant-Governor to forward, for the orders of the Government of India, the revised estimates for the Kidderpore Docks, which have been submitted by the Port Commissioners after a full consideration of the opinions expressed by the Engineers who have been consulted by the Secretary of State and the Government of India. The various

Government of India's No. 142 M., dated the 9th April 1884.
Government of India's No. 176 M., dated the 30th April 1884.
Government of India's No. 178 M., dated the 2nd May 1884.

modifications in the design which have been suggested are very fully and ably discussed by the Commissioners in the report which accompanies the estimates, and it will be observed that, while some of them have been adopted, others have not; and in such each where they have not been adopted some other change has been made in the design to meet the objections raised, or reasons have been given for not adopting them. I am to submit the following observations with regard to each of the questions which have been discussed.

2. *Depth of the Docks and Entrances.*—On this point the opinion expressed by Mr. Rendel was that the depth proposed for the docks, for all parts of the scheme, was insufficient; that the entrances should be made at least three feet deeper than proposed, and the basin at least two feet deeper than the entrances; and, finally, that the passages leading to the docks should be made five feet deeper than proposed, and the docks two feet deeper than the passages.

3. The conclusion arrived at in Mr. Buckley's note is that the entrance sills should be as least two feet lower than shown in Mr. Bruce's designs, if not three feet as recommended by Mr. Rendel. And in the joint note by Colonel Brownlow and Mr. Molesworth it is recommended that the increased depth of two feet should be made obligatory. In both notes Mr. Rendel's suggestion to dig the bed of the basin two feet lower than the entrance sills is approved.

4. In the revised design these recommendations have been so far adopted that the levell of the masonry in the entrances and basin have been made two feet lower throughout with reference to datum. That is, the coping is now altered from 26 feet to 24 above datum and the sills from 14 to 16 feet below datum. The level of the bottom of the wells, so far as such level can be fixed beforehand, will now be 28 feet below datum in the entrances, 26 feet below datum in the basin, and 22 feet below datum in the docks. The bed of the basin wilt be excavated to 18 below datum, or two feet below the entrance sills, to allow for the deposit of silt. And the bed of the docks will be excavated to 14 feet below datum instead of 12 as in the original design. This is two feet below the level of the sills in the passages. The level of the top of the walls of the dock will be 25 feet 6 inches above datum, which is 1 foot 6 inches higher than the level of the basin walls.

5. It will thus be seen that, while an additional depth of two feet has been given through, out the docks, the full increase suggested by Mr. Rendel has not been adopted. He proposed, for one reason, to lower the entrance sills by three feet, and, for another reason, to lower the dock passages by five feet. The reason for the former proposal was that ships should have at least one hour on the rising tide before high water for entering the docks. But Mr. Buckley shows that for every foot the sill is lowered, an extra half hour or so will be afforded for the entrance of ships of deep draft on the rising tide; and that, taking the rising and falling tide together, that is, if ships enter and leave the dock after the turn of the tide, the difference in time due to every foot the sill is lowered amounts to about 1¼ hour. Therefore, the additional depth of two feet, which has been given, more than provides for the safe time required for docking and undocking about the period of high water. At the depth at which Mr. Bruce first fixed the entrance sill, ships had from 1 to 2 hours, during which there would be sufficient water on it to admit of their passage. But by lowering the sill two feet this time is increased to 2 or 3 hours on the rising tide, and to nearly double that time if the rising and falling tide be taken together. For these reasons it appears to the Lieutenant-Governor that the two feet of deepening now provided for in the estimate will meet all requirements, and that it is unnecessary to provide for any more.

6. *Method of filling the Docks with water.*—The reason given for Mr. Rendel's other proposal to deepen the docks and passages leading to them from the basin by five feet is based on different grounds. These are his objections to the proposed method of filling the docks by pumping and his preference for the plan of admitting water from the river. This matter has been fully argued out in the papers attached to the report, and it is unnecessary here to do more than record His Honor the Lieutenant-Governor's concurrence in the views which have been adopted in favour of Mr. Bruce's original scheme for feeding the docks with water by pumping.

7. *Position of Pumping Station.*—In the revised plan now submitted, the position of the pumping station has been changed in accordance with the views expressed in the opinions received from the Government of India, and advantage has been taken of this change to place the boat lock and pumping station on the canal, instead of between the canal and the dock.

8. *Terminus of Boat Canal.*—The other alteration which was suggested in the memoran-

dum by Colonel Brownlow and Mr. Molesworth to terminate the canal at the end of No. 2 Dock furthest from the river has not, however, been adopted. The objections to the position of the canal have been met by other means, which are explained in the 5th paragraph of the report, and I am to state His Honor the Lieutenant-Governor accepts the conclusions arrived at by the Dock Committee.

9. *Width of Docks.*—The next important matter is the question of the width of the docks, and with reference to this I am to state that the Lieutenant-Governor desires strongly to support the view of the Port Commissioners that the width should be 600 feet. The only argument in favour of the reduction of width is that of saving in expense, and the estimates show that this would amount in round numbers to nine lakhs of rupees. His Honor fully shares in the opinion of the Port Commissioners that this saving would not compensate for the greater advantages secured by adhering to the width of 600 feet originally proposed. It is an undeniable fact that in India everything of the nature of space accommodation has, on account of the climate, to be provided on an enormously larger scale than is necessary in England or in any temperate climate. The only inference as to the proper dimensions of a house or a barrack in India that can be drawn from the experience of England is that the dimensions in India should be very much larger than those in England, and a similar inference is certainly justifiable in the case of docks. The deliberate recommendation of the experienced officers of the Port of Calcutta, who are not unacquainted with English practice, as to the most suitable dimensions for the docks here should have more weight than the argument that a particular width is found to be sufficient in England. The Lieutenant-Governor trusts, therefore, that the Government of India will adopt those recommendations.

10. *Position of Entrances and Graving Docks.*—No alteration has been made with regard to these from the original design. The papers show that Mr. Rendel's suggestions have received the fullest consideration, and that the arguments in favour of adhering to the original designs have prevailed.

11. *Depth of the foundations of the Docks.*—The foundations have now been carried ten feet below the bed of the docks, as recommended by Mr. Rendel. The report explains the method proposed to be adopted in the construction of the quay walls, in order to avoid as much as possible, any risk of a slip occurring or of the soil below them being blown in. By this method it will be possible to avoid bringing any pressure to bear on the back of the walls till the water is admitted into the dock so as to afford a counter-pressure from the front. Calculations have been made in this office as to the stability of the wall designed by Mr. Bruce, and it has been suggested to him that it would be advisable to throw back the body of the wall above the line of the top of the well 12 or 18 inches, and to bevil off the off-set that would then be left in front. The reason for this suggestion is that the calculations show that the intensity of the pressure on the base of the wells might, under certain conditions, be very unequal, thus giving rise to the fear of unequal settlement. Mr. Bruce, in agreeing to this suggestion, pointed out that in practice it would be necessary to leave the proposed off-set along the top of the wells, for it would be impossible to sink these in a perfectly straight line, and the off-set would be necessary to allow of the rectification of the alignment of the upper part of the wall.

12. *Extension of Port Commissioners' Tramway along the Strand bank to Kidderpore.*—This work appears to the Lieutenant-Governor to be an essential feature of the Kidderpore Dock scheme, as stated in the report. The chief objection to it raised in the Secretary of State's Despatch is that it would destroy one of the most frequented drives in Calcutta, that along the river bank, and be a source of much inconvenience to the public. But in Mr. Rivers Tompson's opinion the creatoin of a large docking suburb at Kidderpore will have this effect whether the tramway is made or not. An immense goods traffic at least must arise along the Strand Road between the mercantile quarter of the town and the docks. If the tramway is built, this traffic will be conveyed in the least incovenient, the most orderly and inexpensive way possible. If the tramway is not made, the traffic will not on that account be diverted to any other route, but will proceed by the same road, only in the most exasperating of all ways so far as the convenience of the public is concerned,—that is, by crowds of bulluck carts and hack gharies. The continuance of the Strand Road and Eden Gardens as the evening resort of Calcutta has long been doomed by the growth of the shipping business of the Port. Their popularity has of late much decreased, and the Lieutenant-Governor's attention has been directed to the appropriation of some other part of the Maidan for the evening drive. It is probable that the greatly reduced numbers of the jail population of Bengal will admit of the abolition of the Presidency Jail, and it is under consideration

that the site of it should be made into a garden, with drives along an ornamental lake which can be easily made by joining the neighbouring tanks together. If this project be carried out Calcutta will not feel the loss of the Strand Road and Eden Gardens; and even if it was desirable to maintain them as a place for evening recreation, it would be quite possible to regulate the traffic on the tramway so as to prevent its working at that particular time. But at any rate, the Lieutenant-Governor cannot help regarding the tramway connecting the Kidderpore Docks with the jetties and warehouses in their neighbourhood as an indispensable part of the Dock the scheme. It is pointed out in the report that such a tramway would be a great convenience to the Ordnance and Commissariat Departments, and would place their warehouses at Hastings in communication with the docks and jetties and the whole railway system. On the other hand, it is difficult to imagine any ill effect the existence of the tramway would have on the defences of the Fort. The creation of the docks to the south of the Fort will bring into prominence the necessity for improving the defences of the river below the docks and then the railway along the river bank, extending, as it probably will before long, a considerable distance down the river, will be a valuable adjunct to the defences. On all these grounds the Lieutenant-Governor trusts that sanction for the construction of the tramway will not be withheld.

13. *Estimates.*—These have been carefully examined, and, as far as it is possible to judge from the details of the rates, they seem to be sufficient. A considerable margin has been allowed in most of the rates. The estimate for land is the one that is most uncertain. Experience in acquiring land in Bengal shows how largely such estimates may be exceeded by the valuations awarded by the civil courts. Then, again, the magnitude of the works and the heavy demand they will creaet on the available labour will no doubt affect the rates in some measure. It is inevitable that in the long period of the five years, during which the works will be in progress, many unforeseen wants will arise involving additional work or changes of design which will have their effect on the estimates. For these reasons it was suggested to the Financial Department of this Government, before these revised estimates were received, that in considering ways and means it would hardly be safe to count on the cost of the works being under 300 lakhs . The estimates now submitted amount to Rs. 275½ lakhs for the works, and they provide, as already stated, a considerable margin above the estimated actual cost. The interest on this amount during the progress of the works will amount at 4 per cent. to about 33 lakhs, on the assumption that the amount will be raised by equal half-yearly instalments extending over five years. Of course, if, as is not improbable, the half-yearly loans are of variable amount, larger at first and smaller afterwards, and if, as is also not improbable, the rate of the interest varies, then the aggregate amount of interest will also vary. But the gross amount of the estimates including interest will be covered by, say, 310 lakhs. In the estimate at page 14 the interest charge is calculated on the amount of the estimate for works only, excluding the provision of establishment, tools, and contingencies; but obviously interest will be payable on all heads of expenditure. While thus providing liberally for all heads, it must not be forgotten that much of the marginal allowance provided in the rates of the estimates may be saved. Thus it will be seen from the appendix at pages 31 to 35 that, even including the cost of the railway plant and dredgers, the rate for earthwork is estimated not to exceed Rs. 15-8 and Rs. 17-8 per 1,000 cubic feet for hand excavation and dredging respectively, while provision is made in the estimates at the rate of Rs. 20 per 1,000, and there is a separate provision for tools and plant. In most other classes of work there is a similar margin of 5 to 15 per cent. in the rates provided, and there is besides the separate allowance of 10 per cent. for contingencies.

14. The question of ways and means discussed in paragraphs 20 to 25 of the report has been dealt with in a separate letter to the Government of India, from the Financial Department of this Government, and it need not be further considered here.

15. With regard to the canalization of Tolly's Nullah, and the construction of the canal to connect the Circular Canal with Tolly's Nullah, the subject is under consideration in the Irrigation Branch, and the projects will be submitted as soon as they are ready.

Opinion on certain questions connected with the Kidderpore Docks.

Having before us the last report of the proceedings of the Dock Committee of the Commissioners of the Port of Calcutta, with its enclosures,* we are now in a position to express the following opinions on the points at issue in the matter of the Kidderpore Docks:—

I.—With reference to the depth of the dock and basin, we are of opinion that the values

* Subsequently referred to as enclosure A.

now fixed for the normal bed levels (that is, 16·00 below datum for the basin and 12·00 below datum for the dock) are suitable. In both cases it is proposed that, in the first instance, the beds should be excavated two feet below the normal level. This is a precaution which we agree with Mr. Rendel in thinking to be essential in the basin, and we are of opinion that it is desirable in the dock. The increased depth at which the outer sills have been now placed will give increased facilities for docking and undocking vessels on the rising tide.

We are entirely opposed to the proposal that the docks should be constructed at a low level, and fed directly from the river instead of by pumping. On this point the views expressed by Mr. Bruce on page 61 of enclosure A and the facts given by Mr. Buckley on pages 70 and 71 are important. We consider that the plan of pumping is preferable for these reasons:—

(i) That at all seasons of the year it will greatly reduce the silting both in dock and basin.

(ii) That owing to the facts above quoted, the silting during the rainy season will, with pumping, be least; whereas, under the other arrangement, it would at this time be greatest.

(iii) That by pumping, greater purity of the water in the dock can be insured.

(iv) That the difficulties which would be involved in sinking the dock to a lower level would be great and the expense proportional to the difficulties.

II.—Concerning the question of the width of the dock, we are unable to concur in the opinion of the Dock Committee, expressed at pages 4 and 5 of enclosure A, that the width of the dock should be maintained at 600 feet. It is true that the saving effected by reducing the width of the dock is comparatively small, but after giving due weight to all the arguments advanced in favour of the geater width, we do not feel justified in recommending that it be adhered to, as we believe that a width of 500 feet, which we now recommend, will satisfy the requirements of the shipping and cargo boats.

III.—The explanation given by Mr. Bruce on page 65 of enclosure A fully justifies, in our opinion, the maintenance of the original design of the basin and entrances and the position of the graving docks.

IV.—With reference to the depth of foundation of the dock walls, Mr. Rendel says:—

> "In such ground as will be met with in Calcutta, I feel sure that if the walls are not sunk 10 or 12 feet below the bottom of the dock, the ground behind them will sink and flow under them."

In this opinion we concur. Indeed, if the nature of the soil be such as there seems reason to suppose it may be, we doubt if even the depths of foundation proposed by Mr. Rendel will suffice for the wall as designed by the Engineer to the Port Commissioners. It will be seen from paragraph 12, page 6 of enclosure A, that it is proposed to construct the dock wall in such a manner that it will have the pressure of 16 feet of water to support it—

> "before the earth in front is removed, and the chances of any slip occurring or of the bottom blowing up will, by adopting this arrangement, be very small indeed."

It is not, in our judgment, desirable to place much confidence in the increased stability which the wall may gain by the existence of water in the dock. It will certainly never occur that the dock, after its construction, will be without any water in it. It is but barely possible that the water will ever fall to low-water level; but, in our opinion, it is essential that the stability of the wall, when fully backed up to quay level, should be ensured when the water in the dock is at low-water level. As a fact, the water at this level affords a support to the wall which is inconsiderable; it is therefore desirable, we think, to design the wall without reference to the aid which it will undoubtedly receive from the water when the dock is full.

The method of construction described in paragraph 12 of enclosure A is apparently proposed on the hypothesis that it will not be possible to work dry at a lower depth than 3·00 feet below datum, but we have reason to suppose that it may in many places be found quite feasible to work with but moderate pumping power at lower depths than this, and we consider it most desirable that this should be done, whenever possible.

It cannot be decidedly stated what the nature of the soil will be on which the dock wall will be founded; it is known that it will be of variable consistency; layers of soft peat are occasionally met with; clay and sandy silt also occur. This sandy silt is, when saturated liable to slide at a comparatively small angle, and wet clay is notoriously a dangerous and treacherous soil to work in. It has been assumed, and we are ourselves of opinion, that the natural angle of repose of the soil on which the foundations of the dock wall will rest cannot be safely taken at more than 3 to 1, which is equivalent to an angle of about 18½°. This angle will probably vary considerably in different parts of the dock, and will almost certainly be smaller in the lower strata, through which the wells will be sunk. It is not impossible that in these lower strata quicksands may in parts be met with. After careful consideration of the circumstances, we are of opinion that the pressures to which the dock wall will be subjected should, in the interests of reasonable security, be calcutated on the supposition that the angle of repose of the earth at the back of the wall will be at most 18½°. Having this in view, we have arrived at the following conclusions:—

1st.—That the total pressure on the base of the wall, at the level of the dock bed, should exceed three times the horizontal thrust of the backing above that level.

2nd.—That the maximum intensity of the vertical pressure on any part of the base of the wall, at the level of the dock bed, when the dock is dry, should not exceed the mean pressure, at the same level, by more than fifty per cent., and when the dock is full, which will be its normal condition, the resultan pressure should pass, as nearly as may be, through the centre of the base a the level of the dock floor.

3rd.—That if well foundations are used, as they probably must be, the wells should be tested before the superstructure is laid, with a pressure which will, at the level of the dock bed, be not less than 125 per cent. of the calculated maximum intensity of pressure at the same level. This test to be applied after the dock has been excavated to bed level for a space of 200 feet in front of the dock wall and maintained for a week.

4th.—That the level of the top of the wells should be kept as low as may be possible in any case not more than 5 feet above the level of the dock bed.

Compliance with these conditions we consider to be indispensable for ensuring the stability of the wall.

The drawings which accompany the last report of the Dock Committee of the Port Commissioners show a section of the dock wall. This, as will be seen from the accompanying diagram No. 1, does not fulfil the conditions we consider essential under the circumstances. This wall, founded on a soil having a natural angle of repose of even 3 to 1, would not, we think, be sufficiently secure, although, under more favourable circumstances, it might be perfectly satisfactory. We annex two sample sections, either of which fulfils the first two and the last conditions. Section B, which is rather the more economical of the two, is the better. In the case of section A it would be necessary to test the wells with a pressure equivalent to 3·33 tons per square foot at the level of the dock bed; in the case of section B with 2·43 tons.

We are not prepared to say to what depth it may prove necessary to sink the wells in order to fulfil the third condition. The necessary depths will probably vary considerably in different parts of the dock. It appears to be not improbable that, if section A be adopted, it may be necessary to carry the wells down to between 20 and 30 feet before they could sustain the necessary load. In the case of section B the necessary depth might be from 5 to 10 feet less than in the case of section A. Should, however, the soil prove to be more reliable than we suppose to be the case, these depths may be materially reduced. It is only possible to determine this point by actual experiment.

While this uncertainty prevails as to the necessary depths of the foundations, it is in our opinion impossible to give any reliable estimate of the cost of the dock walls. The revised estimate which accompanies the last report of the Dock Committee gives the cost of these walls, thus:—

	Length. Feet.	Cost. Rs.
Dock No. 1	6,435	27,36,484
Dock „ 2	9,440	39,97,350
Basin	2,030	8,95,738
Total cost of dock walls . . .		76,29,572

To this sum we consider that it will in any case be necessary to add at least 30 per cent, and it may possibly be necessary to increase this item even more largely. We have doubts whether it will be possible to sink the wells without well curbs in the manner proposed by Mr. Bruce, and curbs would increase the cost considerably. On the other hand, it is by no means impossible that a portion of the foundation may be laid without wells.

On the whole, we are of opinion that it will be advisable to add at least 10 per cent. to the total amount of the last estimate for works exclusive of contingencies, submitted by the

Government of Bengal, to provide for the constructive difficulties which are likely to be entailed by the character of tho subsoil in which the dock wells will have to be founded.

W. S. TREVOR.
HENRY A. BROWNLOW.
GUILFORD L. MOLESWORTH.
R. B. BUCKLEY.

SIMLA;
August 12th, 1884.

From the Government of India, to Her Majesty's Secretary of State for India,—No. 44, dated 29th August 1884.

Telegram, dated 7th March 1884.
Despatch No. 13P.W., dated 6th March 1884.

We have the honour to acknowledge your Lordship's communications specified in the margin, on the subject of the Calcutta Docks, and beg to express our satisfaction, as well as that of the local authorities and the mercantile community, at the settlement of the prolonged controversy regarding the provision of additional facilities for the port of Calcutta, by the acceptance of our conclusion that docks should be constructed at Calcutta itself, and on the Kidderpore site.

2. Upon the receipt of these communications we authorised the Government of Bengal to take such steps as they thought advisable for the acquisition of the land, and requested them to favour us with their opinion on the engineering, financial, and other questions involved after consulting the Port Commissioners. We also at once took the engineering questions into consideration, and on the 30th April forwarded to them certain enquiries, together with a note by Mr. Buckley, one of our Under-Secretaries in the Public Works Department, and a joint note by Mr. Molesworth and Colonel Brownlow.

3. We now forward the reply of the Bengal Government, No. 1228 M.P.I., dated 17th July 1884, together with the report and revised estimates of the Port Commissioners. Among the appendices to the latter will be found our letter of 30th April and its enclosures, above referred to.

We have considered these documents with much care, and append a joint note on the more important engineering points at issue by Colonel Trevor, Mr. Molesworth, Colonet Brownlow, and Mr. Buckley. We will now explain our conclusions on this branch of the subject before noticing the financial arrangements for giving to them full effect.

4. *Depth of Docks and Entrances.*—Mr. Rendel's suggestion that the depth of these should be increased is generally admitted to be a sound and valuable one, and an increase of two feet throughout has been provided accordingly. The local reasons explained by the Port Commissioners and the Bengal Government satisfy us that a further increase in the case of the entrance sills and dock passages is unnecessary.

5. *Method of filling the Docks.*—We concur with the local authorities in a decided preference for the method of pumping, for reasons specified in the joint note above referred to. The position of the pumping station and boat lock has been advantageously shifted to the entrance of the canal.

6. *Width of the Dock.*—The Port Commissioners and Local Government, while urging that 500 feet is the least width which can possibly be adopted, show, in our opinion, very strong reasons for maintaining the width of 600 feet, originally proposed. The smaller figure they explain, will result in a lower proportion of water space to quay space than exists in Prince's Dock at Bombay, though cargo boats are less used there than at Calcutta. The increasing beam of vessels, they add, postulates a greater width than may have sufficed in English types of older date, while sanitary considerations make against overcrowding in such a climate as Calcutta, and in favour of securing the greater purity of a larger volume of water While reluctant to record an opinion adverse to that of our professional advisers in the Government of India, who consider 500 feet sufficient, we shall feel no regret if your Lordship should think proper, on the evidence presented, to approve of the larger dimension.

7. *Position of Entrances and Graving Docks.*—We concur with our own advisers and the local authorities in recommending an adherence, in respect of these, to the original designs.

8. *Depth of Dock Foundations.*—This highly important and technical matter has been very fully considered, and Mr. Rendel's suggestion for increased depth has been substantially adopted regard being had to the fact that the depths may vary, in different parts of the dock, considerably above or below the average he recommended. Several valuable modifications and suggestions as to details will be found in the papers, but need not be specified here. In this, as in most great works involving construction in a treacherous soil, considerable uncertanity as to the

cost of foundations is unavoidable; but we trust that the large margin allowed on this account will prove sufficient.

9. *Strand Tramway.*—We have bestowed early and special attention, as desired in the 16th paragraph of your Lordship's letter under reply, to the effect of this proposed work on the defences of Fort William, and on the convenience of the public.

His Excellency the Commander-in-Chief is of opinion that on military grounds the tramway is unobjectionable. No buildings connected with it will, of course, be run up within what are known as the military limits of Fort William. The question of the defences of the Hooghly generally is under separate consideration by the military authorities.

With reference to the objection on the score of inconvenience to the public, and the sufficiency of the railway connection with the docks *viâ* Sealdah, we beg to point out that the two proposed lines will serve totally distinct needs. The Sealdah line will be almost entirely used for exports pouring down from up-country; the Strand line will be taken up by local goods conveyed to and fro between the docks and the business quarters of the city, as well as by mercantile passengers, to whom it will be an immense convenience. This traffic is inevitable, and we concur with His Honor the Lieutenant-Governor, to whose remarks, and to those of the Port Commissioners, we invite special attention, that it will be conveyed with less inconvenience to the public by a tramway than by other methods. As an evening resort, moreover, the Strand is already no longer what it used to be, but the due regulation of the traffic at certain hours, which the Local Government contemplate, should remove whatever objection may remain on this score.

10. The question having thus been thoroughly considered, with a result favourable to the project, and the Local Government having urgently represented that the early completion of the latter would effect much economy in the dock works, we have sanctioned its immediate commencement, and trust that your Lordship will approve of our action in this respect.

11. *Howrah Improvements and Boat Canal.*—With regard to the 13th paragraph of your Lordship's letter, we are glad to report that the boat wharves on the Howrah side of the river and the improvements at the Howrah station are being pushed forward satisfactorily, and in an advanced state.

The canalisation of Tolly's Nullah and the connection of it with the Circular Canal are still under consideration in the Irrigation Department of the Bengal Government, but will be undertaken, under your Lordship's present approval, as soon as the projects have been matured.

12. *Estimates.*—Revised estimates for the works, as modified by the various suggestions, which have been accepted by them, are submitted by the Port Commissioners, and commented on by the Bengal Government in paragraph 13 of their letter of July 17th, with the result that the latter consider 275⅓ lakhs for the works and 310 lakhs for the entire outlay, including interest during construction, to be a safe and even liberal figure. Our professional advisers, in their joint note, recommend an addition of at least 10 per cent. to the item for works (excluding contingencies, tools, plant, and establishment) in order to provide for the constructive difficulties likely to be met with in laying the dock foundations. The total estimate, including this addition, but allowing for a reduction of width to 500 feet, is shown in the margin. While by no means disregarding this opinion, we would give due weight to the explanation of the Bengal Government, that, independently of the allowance of 10 per cent. for contingencies which the works estimates already contain, an additional or inner margin of from 5 to 20 per cent. has been provided in the rates for most classes of work.

	R
Estimate for works as at page 14 of Port Commissioners' Report . .	2,33,31,935
Add 10 per cent.	23,33,193
Revised total for works .	2,56,65,128
Contingencies, at 10 per cent. . .	25,66,512
Tools and plant, at 3 per cent. . .	7,69,953
Establishment, at 5 per cent. . .	12,83,256
Total for construction .	3,02,84,849
Interest during construction, at 12 per cent. on above total . .	36,34,182
Grand total for dock 600 feet wide	3,39,19,031
Deduct saving by reduction of dock to 500 feet, say	10,00,000
Grand total for work 500 feet wide . . .	3,29,19,031

In a case where uncertainties as to rate of interest on which loans may be obtainable and amount of annual demands exist in addition to such as are attendant on difficulties of construction, it is obviously impossible to name any sum which may be confidently relied on as a limit of liability. As far as we are able to judge, however, we think the outlay for docks 500 feet wide is not likely to fall within 301 lakhs, or to exceed 329 lakhs. For financial purposes, at the present stage, it may suffice to speak of 300 lakhs in round numbers.

13. *Ways and means.*—The question of the best means of raising the money required for the construction of the docks is one in regard to which we experience considerable difficulty in

coming to a satisfactory decision. Your Lordship has already expressed your willingness to sanction a Government guarantee in the case of this loan. We feel strongly the force of the objections against the system of guaranteeing loans raised by local bodies, but we are prepared to admit that the circumstances of the present case are exceptional. The docks will be of great public utility, and the fact that Government owns all the chief railways converging on Calcutta affords a strong argument for the grant of special assistance.

14. The Port Trust, it may also be allowed, could only raise the sums required, if not supported by a guarantee, at a cost which would impose a heavier burden on the trade of the port. For these reasons, we are willing not to press our objection to a Government guarantee in the case of the proposed docks; but we wish to guard ourselves against similar claims on the part of other local bodies by placing on record our opinion that such guarantees must not be made the rule, and that they should only be given in very exceptional cases. The more guarantees are given, the more necessary it becomes to give them. Unsupported local securities are discredited, because it is argued that, if they were of value, the Government, usually so liberal in its guarantees, would not have hesitated to guarantee them. There being, on the other hand, necessarily limits to Government guarantees, *bonâ fide* enterprises are thus discouraged, and artificial difficulties are created in the way of obtaining accommodation. The question of the guarantee being, however, in this case, for the reasons above given, waived, there remains the further question of the place and manner of borrowing.

15. The question of borrowing by local bodies cannot be thoroughly considered apart from the question of the borrowing by Government in future years for productive or protective public works. On this point we have now before us the conclusions of the Select Committee of the House of Commons. We await your Lordship's remarks on their recommendation; but we may meanwhile say that it is becoming more and more evident that the 75 lakhs of the yearly grant for famine relief and protection, which is not devoted to the construction of protective works, cannot with advantage, for the next few years, be devoted to the actual reduction of debt, but must be applied to increasing our balances, and so diminishing the amount which we shall require to borrow. Even with the assistance to be afforded in this way, we cannot anticipate that our borrowing for the next five years will come to less than a yearly average of two crores. It is difficult to say whether we shall be able to borrow in India so much as ten crores within the next five years at a rate of interest not in excess of 4 per cent., but we may be able to do so; and so long as your Lordship can borrow at not more than 3½ per cent. in England, we are clearly of opinion that we should not be justified in borrowing at a higher rate than 4 per cent. per annum in this country.

16. The possibility of our being able to borrow at a reasonable rate in this country during the next five years will be at the least very seriously diminished if local bodies are at the same time to place loans of considerable amount on the Indian market. And our present information leads us to anticipate that local bodies will desire to raise loans of large aggregate amounts during the immediately ensuing years.

For the Calcutta Docks a sum of at least 3 crores will be required; for other purposes the Calcutta Port Trust requires to raise 30 lakhs this year; and the Calcutta Municipality has already applied for permission to raise in London £350,000.

For the Madras Harbour it is probable that a sum not much short of 50 lakhs will be required; and though we lately refused an application from the Bombay Port Trust to borrow from Government 96 lakhs for the purpose of extending dock accommodation in Bombay, the sum in one form or another will probably have to be raised. The Bombay Municipality is also contemplating the extension of their system of water-supply at a very heavy cost.

Without attempting any very accurate forecast, we certainly cannot place the wants of local bodies during the next five years at less than five crores of rupees.

17. The total demands on the Indian market will therefore be larger than it can supply at a reasonable rate, and we are of opinion that arrangements will have to be made for raising, during the next five years in England, either on account of Government or local bodies, at least five crores of rupees. If your Lordship should decide to allow local lodies to raise what money they require in England, it may be possible that the Indian market will be able to supply the wants of Government. If, on the other hand, this Government only raises occasional loans of moderate amount in India, and obtains any further sums it may require in England, it is probable that the local market could supply the wants of local bodies. But if it is decided that both Government and local bodies must borrow in India, we anticipate that it will not be possible to raise the necessary loans except on very unfavourable terms, and that, after all, it will be found impossible to avoid having resort occasionally to the home market. As local bodies appear generally to be of opinion that it would be to their

advantage to borrow in London and in gold, and are willing to do so, we do not think it is sound policy to oppose their wishes in this respect.

18. Self-interest is a valuable guide in such matters, and the lower rate of interest payable on gold loans is sufficient to cover any probable future fall in the price of silver, while the borrowing by local bodies in England would leave the Indian market free for our operations.

19. In regard to the specific case of the money required for the construction of the Calcutta Docks, your Lordship will observe that the Government of Bengal, in their letter No. 1415T.F., dated June 25th, 1884, recommended that the money required for the docks should be advanced by Government to the Port Commissioners as required from time to time at 4 per cent., and that when the works are completed, the Port Commissioners should raise a guaranteed loan in England or in India, and repay the whole sum advanced. To carry out this plan, it would be necessary that the sums required by the Port Commissioners should be borrowed by Government; and, for reasons already stated, the borrowing must be in England. But as money could be raised in England at less than 3½ per cent., and as the Port Commissioners would be charged 4 per cent., the difference of rather more than ½ per cent. would be ample to cover any probable loss due to fall in the price of silver up to the time when the loan would be repaid by the Port Commissioners. If, however, Your Lordship should be of opinion that objections to any increase, even though it should be more apparent than real, of the sterling obligations of the Government of India are sufficient to counterbalance the obvious economy of the plan recommended by the Government of Bengal, it will only remain to decide whether the Port Commissioners should borrow on a Government guarantee in India or in England. The Port Commissioners are of opinion that they could perhaps borrow on a guarantee at 4½ per cent. in India, and probably at 3½ per cent. in England. We agree with the Port Commissioners in thinking that even with a Government guarantee they are not likely to get a better rate than 4½ per cent. in India, and your Lordship will be in a position to decide whether they are likely to be able to borrow at 3½ per cent. in England.

In our opinion, if they should be able to borrow at 3¾ per cent., or even at a slightly higher rate, in England, it would be more economical to allow them to do so than to force them to borrow at 4½ per cent. in India.

20. In the meantime, as the Port Commissioners were in want of money to meet the cost of preliminary operations connected with the new docks, we authorised them by a Resolution, No. 2314, dated 18th July, published in the *Gazette of India* of the 19th idem, to raise a sum not exceeding 50 lakhs in the Indian market this year on a Government guarantee.

Difficulties, the nature of which is indicated in the Bengal Government's letter No. 1501 of the 4th instant, having, however, been experienced in passing a short temporary Act to enable the Port Commissioners to raise a loan for the purpose of constructing docks, we have decided to withdraw the notification. We have advanced to the Port Commissioner 15 lakhs of rupees, which will, we hope, be sufficient to meet urgent expenditure until an Act can be passed amending the present law, and we have requested the Bengal Government to take measures for proceeding with the necessary legislation with the least avoidable delay.

21. *Conclusion.*—The Port Commissioners having thus been placed in funds for the present, will be able to proceed with the acquisition and clearing of the ground and the commencement of such portions of the project as are not under reconsideration, in accordance with the permission granted in the concluding paragraph of your Lordship's despatch. In order, however, to obviate delays hereafter, which might be productive of extra expense as well as inconvenience, we trust that we may be favoured at the earliest practicable date with your Lordship's decision on both the engineering and financial questions now submitted.

From the Secretary of State for India, to the Government of India,—No. 73, dated 27th November 1884.

I have had under consideration in Council your letter No. 44 Public Works, dated 29th August last, on the subject of the proposed Kidderpore Docks at Calcutta.

2. The question of site has now been definitively settled, and I am glad to learn that the Strand tramway, which is intended to connect the docks with Calcutta, can be constructed without any fear of interference with the military defences, and without any inconvenience to the public.

3. You informed me by telegram, on the 4th September, that you had authorized the Port Commissioners to acquire and clear the necessary ground, and had advanced to them 15 lakhs for the purpose.

4. Preparations have thus been made for proceeding with the work as soon as certain

engineering points still under discussion have been decided, and the necessary arrangements have been made for providing the funds.

5. As regards the engineering questions, Mr. Rendel was requested, on the receipt of your letter under reply, to furnish me with his remarks on the conclusions which had been arrived at by the professional advisers of your Government and of the Port Commissioners. I now forward a copy of his report* thereon, and will express my views on the several points requiring notice.

* Dated 18th October 1884.

6. But, before proceeding to speak of matters of detail, it is necessary to recur to a larger question brought before your Excellency's Government in my despatch of the 6th March last. It was there said:—

> "Mr. Rendel's observations regarding the depth, size, and general proportions of the proposed docks, and the mode of constructing them, and *his suggestion that a smaller dock area and one entrance would be sufficient, are deserving of serious attention*, and I request that, before plans are finally prepared, I may be informed of the view taken by the professional advisers of your Government and of the Port Commissioners on his comments, particularly with reference to the relation between the magnitude of the proposed docks and the quantity of shipping to be accommodated, and after careful inquiry into the actual results obtained by experience at other ports. I request also to be furnished with any modified design which your Excellency may find it desirable to recommend. You will readily perceive the necessity of observing the utmost caution in a matter of such importance, in order to avoid, as far as possible, any mistake at starting."

7. Mr. Rendel, in urging for consideration whether a much smaller scheme would not suffice, had also observed:—

> "In these days of rapid despatch ships stay in dock but a short time, and therefore a very small amount of water space, well laid out in respect of quay wall and quay space, will provide for a very large trade. *Would it not be sufficient, therefore, to confine operations for the present to a basin and dock measuring together 50 acres?* Such a basin and dock might be designed to supply between 11,000 and 12,000 lineal feet of quay wall available for the berthage of ships; and one lock, say 500 feet long and 70 feet wide, without other entrance between the basin and river, and one passage with a single pair of gates, between the basin and the dock, would supply all the necessary entrance accommodation. No more was supplied to the Victoria Dock, built 30 years ago, or to the Albert Dock, designed 10 years ago, although each measures about 90 acres in area; and although the large traffic alone of the Victoria Dock keeps its lock employed about seven hours of every tide, no more would be now required, if only the present entrances were deep enough."

8. These observations are commented on by Mr. Duff Bruce at page   of the printed enclosures which you forwarded from the Government of Bengal. But in your despatch I do not find any reference made to this important question, except in so far as it is contingently, and very partially, affected by the discussion of the greater or less width to be given to the docks.

9. While I entirely recognise the necessity of expanding the shipping accommodation of Calcutta by the construction of docks, I cannot but feel that you are embarking on a very serious enterprise. Mr. Rendel, whose authority on such a question commands the highest respect, does not hesitate to say that, in his judgment, "no docks have yet been built which have involved so many and such serious risks as these." Under ordinary circumstances, as he points out, dock walls for such depths as are in question can be built in England for 10*l.* or 15*l.* per foot run, whereas Mr. Duff Bruce's own estimate for the project amounts to nearly 45*l.* per foot run, and this is raised by your Committee of Engineers to nearly 60*l.* So great an excess of cost indicates an excess of risk which may really defy trustworthy estimate. And I see no ground for questioning the soundness of Mr. Rendel's judgment when he repeats his conviction that "the scheme should be started on the smallest possible scale, with the fewest unproductive works possible, and with no illusions as to the character of the ground."

10. It is not, in the case before me, as if by the limitation of the scheme to be at first undertaken, any material delay would necessarily be caused from changes of project or renewal of discussions, or even that, should experience justify the extension of the work, the completion of the undertaking on the scale now designed would eventually be much retarded.

11. As the instances quoted by Mr. Rendel show (and a variety of others might be cited), the history of nearly all dock projects is a history of such extensions. The creation of docks will not abolish the river port or detract from its present amount of accommodation. The very fact of the limitation of the scheme will enable the smaller area of dock to be brought into earlier use,—earlier in all probability by some years than could be expected for the entire project. The progress of the more limited construction will certainly afford experience that will render the extension more sure and economical in execution. Nothing done in the completion of the smaller scheme will require to be undone in order to extend it hereafter: nothing done in carrying out the smaller scheme need obstruct the eventual extension.

12. And when I consider the very large demands for funds which are in the forecasts of

your Government for expenditure in India during the next few years, I cannot think it expedient to launch into so great a project at once, when no injury that I can foresee will result from the limitation of the works to be immediately undertaken.

13. The total area of water space in the project is as follows :—

	Acres.	Acres.
Tidal basin	9·8	
Dock No. 1	36·33	
		46·13
Dock No. 2		64·75
		110·88

14. By deferring the construction of Dock No. 2, we should have an area of nearly 50 acres for the first instalment of the scheme, and to that extent of work I limit my present sanction of the project. This may be estimated to reduce the total outlay now contemplated from about 3 crores to 2 crores of rupees.

15. I now proceed to notice some points of detail which are the subject of discussion.

Depth.—Mr. Rendel continues to think that the depth of the docks and the passage to them should be increased by 3 instead of 2 feet as now proposed. Unless very strong grounds can be urged against his view that "another foot will add nothing to the difficulty, and not much to the cost," I am of opinion that the depth which he recommends should be adopted.

Width.—Your professional advisers have concurred in the reduction of width from 600 to 500 feet. Had I been sanctioning the scheme on its entire magnitude, I should have given the preference to this reduced width. But observing that your own preference, as well as that of the Government of Bengal and the Port Trust, is for the larger width, I do not object to it, with the remark that, in the case of the future extension of the project, it may be advisable to adopt the reduced width, should experience justify this.

Position of Entrances and Graving Docks.—Mr. Rendel adheres to his former opinion on this point, and I will only request that the particular attention of your professional advisers may be given to his further remarks.

Depth and character of Dock Foundations.—You state that "Mr. Rendel's suggestions for increased depth have been substantially adopted." Mr. Rendel, however, evidently has misgivings on this "most serious matter," and you will, no doubt, cause his suggestions and recommendations to be very carefully considered. I also recommend to special consideration what Mr. Rendel has said in regard to the comparative merit of pile and well foundations for such a work as this, and particularly his observations that even though wells may be more suited for the foundation of the dock walls, piles would be better adapted for the entrances. These are points upon which no room should be left for doubt, and every care should be taken to adopt the safest course.

16. With regard to "ways and means," you will have received my despatch of 22nd August (Legislative), in which I informed you of the decision of Her Majesty's Government on the proposed measure for enabling the Port Commissioners to raise money in this country. I must repeat the opinion expressed in paragraph 11 of my despatch of 6th March last, that "the ultimate charge for these works should not fall on the general revenues, and that the Port Commissioners should be empowered by a local Act to raise the money required under the guarantee of the Government, but subject to the control of the Government of Bengal;" any necessary advances of interest being charged against the provincial revenues, aided, if necessary, by your Government.

17. I shall address you further, in the Financial Department, on the question of the manner in which money shall be raised for this and the other large works described in the 16th and following paragraphs of your Excellency's letter.

Report.

I have considered these papers, and have to offer the following observations upon them. I shall base my remarks on the despatch from the Government of India No. 44 Public Works, dated Simla, 20th August 1884, paragraph by paragraph.

4. *Depth of Docks and Entrances.*—I advised that the cills of the entrance lock should be lowered 3 feet. This is accepted to the extent of 2 feet. I still think 3 feet desirable. The object I had in view was to lengthen the time during which heavy vessels could pass in or out

of dock; my view, which appears to be assented to, being that they can only do so on the rising tide. To this, on a perusal of Mr. Buckley's very useful note, I now add the further reason that there is ground to believe that there may sometimes be a bank of silt in or in front of the lock, the top of which may be higher than the cill at whatever level it is placed. I do not regard the depth in the river outside as an important factor in the question.

Another foot will add nothing to the difficulty and not much to the cost of the work, and might turn out to be of great value; and it might be confined to the outer cill and the lock pit, though I think this not very advisable.

I also proposed that, as is usual in docks, both basin and dock should be 2 feet deeper than the entrances to them to provide room for accumulation of silt without practical loss *of depth*. This is agreed to.

5. *Method of filling the Docks.*—It was originally proposed to make the passage between the basin and the docks 4 feet shallower than the river entrance, and to make the docks 4 feet shallower than the basin. It being now proposed to deepen the river entrance by 2 feet, the passage between the basin and the dock will be 6 feet shallower than the entrance lock. The docks will also be 6 feet shallower than the basin. But, inasmuch as the docks if so built will, taking into account the water required for lockage, &c., be often too shallow for heavy vessels, the requisite depth is to be obtained in them by pumping water into them from the adjoining canals.

I urged that the docks should be made of the same depth as the basin, and that water for lockage, levelling, and so on should be obtained in the usual way by the natural inflow of the tide at high water from the river. Judging from what I then knew, I thought pumping would increase the deposit of silt in the dock, and I knew that it involved inconvenience which would make the working of the docks less simple than it should be.

From what Mr. Buckley now tells us of the character of the water which will be used if pumping be resorted to, it seems that the quantity of silt brought into the docks by pumping may be even less than the quantity which would come into them from the river. If this be so, it is a clear reason for supplying the water requisite for lockage by pumping, but it does not seem to me a reason for making the docks materially shallower than the basin, unless, as Mr. Bruce argues, by so doing the cost and difficulty of constructing the dock walls could be materially decreased.

Mr. Bruce's estimates, however, do not seem to support his opinion. Thus, his present estimate for the walls of the basin, the bottom of which is now 18 feet below datum, is R441 per foot lineal; but his estimate for the walls of the dock, the bottom of which is 6 feet higher than the bottom of the basin, is R425 per foot lineal, or only R16 less.

It is true that the walls of the basin are to be only 1 foot 6 inches above highest high water, while those of the dock are to be 3 feet above that level; but 2 feet in a dock wall above high water affected its cost much less than 2 feet below high water, because the water behind the wall above high water can be drained, and the saving here is trifling.

I suggested that the bottom of the dock should be placed at 17 feet below datum, or 1 foot higher than it is now proposed to place the bottom of the basin. If, therefore, the dock were made as deep as I proposed, its walls should cost rather less than those of the basin as now proposed. And if the walls for a depth of 17 feet below datum would cost only 4 per cent. more than walls for a depth of 12 feet below datum, then, looking to the enormous value of depth, I cannot understand why this shallow depth should be preferred.

I do not think the sanitary advantage claimed for pumping will bear close examination. The water in the dock will not have sufficient movement to prevent foul matters falling to the bottom, and there is no real cause for expecting that the docks will be injurious to the health of Calcutta under any circumstances.

I can therefore only say, as I said before, that I think it will be a matter for great regret if the depth of the docks and of the passage into them is not increased. I withdraw, on the information now before me, my objection to pumping as a means of supplying lockage water, &c., but I do not think that it should be relied on to the extent of making the docks so much as 6 feet shallower than the basin. I should think, however, a difference of 3 feet justified.

6. *Width of Dock.*—I do not suppose that cargo boats will play a greater part in docks on the Hooghly than barges do in docks on the Thames, and double tiers of ships alongside the quay will not give satisfaction to shippers, and should be avoided if possible. But if double tiers are probable, the case for giving the docks the maximum of quay wall for a given water area is strengthened. It may be that the difference of cost between a width of 600 feet and 500 feet is only 10 lakhs. The question is, could not the 10 lakhs be spent better in lengthening

the docks instead of widening them? The paying part of a dock (I mean, of course, the directly paying part) is the quay wall. The water space, the entrances, and such like pay only indirectly, and any of them which are in excess of actual requirements only represent so much waste; and in respect to such works, especially in such costly docks as these, it is better to err on the side of too little than on that of too much.

7. *Position of Entrances and Graving Docks.*—In regard to the river entrances, I suggested that a second entrance might be dispensed with. It had passed out of my mind that in the rainy season the current is sometimes always downwards, and that, on such occasions, the single entrance alone might be available. This is, of course, a full answer to my objection to it. But it is, I think, to be wished that some way could be found of avoiding a second entrance; for it represents so much more money spent without a possibility of direct return, and so much additional danger of mishap. I cannot think that my objection to the site of the graving docks is answered, and my comment on the passage between the docks and basin is not noticed. In respect to the graving docks, I am convinced that the placing of them in the basin is a mistake. The handling vessels in and out of them will disturb the ordinary traffic of the basin, and will prevent the basin from being used for the berthage of ships, for which it will certainly be in great request, especially if the docks are worked as is proposed.

In respect to the passages between the docks and the basin, I am satisfied that one is enough, and that the cost of the second is so much money thrown away.

8. *Depth of Dock Foundations.*—This, of course, is a most serious matter, and the more it is considered, the more serious it will appear.

Mr. Buckley expresses his surprise that I should think the dangerous period will extend beyond the time when the water is let into the dock. He says, and says truly, that the pressure of the water in the dock on the outside of the wall will balance a part of the pressure of the earth on the inside. But in ground such as we have to deal with here, the letting in of the water will make a total change in the conditions affecting the stability of the wall.

If the water is let in in front of the wall, it is also let into the back of the wall, either by stoppage of the drainage or by percolation from the front, probably both. The pressure behind the wall is then increased, because the backing, especially if it be as described by Mr. Bruce, "river silt," is loosened by the water. Again, the wall itself becoming immersed in water, a portion of its weight, which is its chief strength, is lost; and worst of all, the ground on which it stands becoming saturated with water is weakened to an extent which makes calculation of the load it will carry impossible.

For these reasons it is utterly impossible to build a wall on such ground as we have to deal with here in reliance on any formula. We only know that the foundations must be wide and deep. But how wide and how deep, example, specially of failures, and experience alone can tell us. At Grimsby we found walls of any kind absolutely impossible. We had to surround the dock by an arched viaduct founded on piles, the sides of the dock being held up by banks of chalk thrown in under the viaduct. I doubt if this is practicable here at a reasonable cost, but it is worth consideration on the spot. On one side of the Shadwell Basin in London we had to do something of the same kind. At the Tilbury Docks, now under construction, it was supposed that the ground would stand at a slope of 1½ to 1. It has been found necessary here, before the water is let in, to slope those parts of the dock and basin sides which are unwalled to an angle of 6 to 1, slopes of 3 to 1 having been first tried and failing. The timbering used for the trenches by which the walls for this dock are got in is heavier than has been ever used, and has yet sometimes failed. How the walls will turn out remains to be seen. Fortunately they are founded on gravel overlying solid chalk. The ground at Tilbury consists of the silty clays and peats which generally overlie the gravel of the Thames, and are, I should conjecture, not unlike what will be found at Kidderpore, with the exception that no solid gravel will be reached there.

In respect to the walls, I agree very much with the note signed by Colonels Trevor and Brownlow and Messrs. Molesworth and Buckley. I think their section B, or its equivalent, will at least be required. I would suggest, however, for consideration that larger wells might be employed, say 2 of 18 feet rather than 3 of 11 feet 6 inches, and that the upper part of the work should consist of a wall at the back, with buttresses in front projecting out to the face of the intended quay. The buttresses might be connected by girders planked over to form a quay. The great object would be to design the walls so that in case of movement the injury to them should be the least possible. I may perhaps be allowed to observe also on a matter of detail that battering walls are not suited to the straight-sided ships now in use, and that the face of the quays should be vertical.

I judge from the wording of this paragraph that the Government thinks more lightly of the difficulty which will be encountered in the construction of these docks than I do. I do not hesitate to say that, in my judgment, no docks have yet been built which have involved so many and such serious risks as these. That they can be built I do not doubt, but their cost will be enormous for their area, and I do not envy the engineer who will be charged with their supervision. In respect to their cost, I may observe that, under ordinary circumstances, dock walls for depths such as we are dealing with may be built in this country for from 10*l.* to 15*l.* a foot run. Here even Mr. Bruce's estimate is R445, and the other gentlemen I have named place the cost 30 per cent. higher, exclusive of contingencies; and all the other works, except the excavation, are something like the same ratio.

The scheme therefore, it seems to me, should be started on the smallest possible scale with the fewest unproductive works possible, and with no illusions as to the character of the ground.

In respect to this I should observe that since I wrote my note of January last the entrance to the Howrah Dock has failed very soon after its completion.

Mr. Bruce telegraphs that the ground there was quicksand, and that here it is the same as at Chitpore. Mr. Buckley has answered this beforehand in his note upon mine. But apart from that, there is no reason to suppose that the ground on the one side of the river is practically different from the ground on the other. The borings taken at Kidderpore show sandy silt, and borings—or rather their interpretation—notoriously err, as a rule, on the side of making ground appear better than it is. I strongly suspect that when the soil at Kidderpore is placed under hydraulic pressure it will prove to be exactly the same as that which now, after the work has failed, is called "quicksand" at Howrah, and if it is not treated accordingly, the same results will ensue.

I should observe, in conclusion, that it appears to me by no means certain that well foundations are to be preferred to piled. Wells take the place of piles in India because in India timber suited to piling is scarce. But piles may be imported into Calcutta at small cost for transport, and when it is remembered that the tendency of well-sinking must be to loosen the surrounding ground, whilst that of pile-driving is to consolidate it, and that piles would be driven much deeper than wells would be sunk, it becomes obvious, I think, that designs for both walls and entrances should be prepared on both methods of foundations, in order that their relative advantages might be properly compared.

The Howrah entrance was, I observe from Mr. Bruce's telegram, founded on blocks,—that is, wells. This may have helped its failure by disturbance of the ground. I should be prepared to find that wells are more suited for the walls and piles (both sheet and bearing) for the entrances.

In any case, I think the wells should be sunk as shown on the plans which accompany Colonel Trevor and Messrs. Molesworth and Buckley's report,—that is to say, a little apart, the space between them being cleaned out for a considerable depth and filled in with concrete, so as to make a solid floor, and not merely as close as possible together as shown on Mr. Bruce's plan.

A. M. RENDEL.

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